

# SCIENTIFIC AMERICAN

## SUPPLEMENT. No 1562

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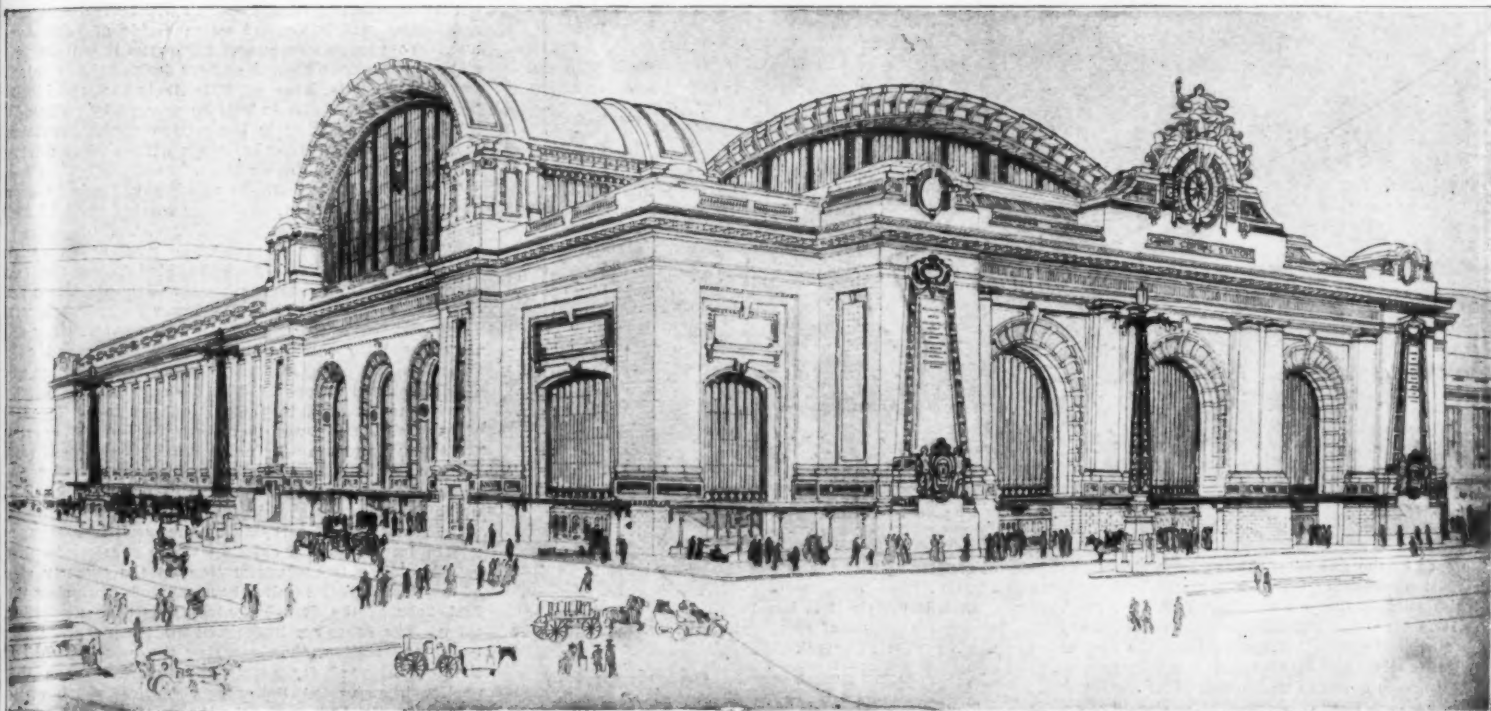
Scientific American, established 1845.

Scientific American Supplement, Vol. LX., No. 1562.

NEW YORK, DECEMBER 9, 1905.

Scientific American Supplement, \$5 a year.

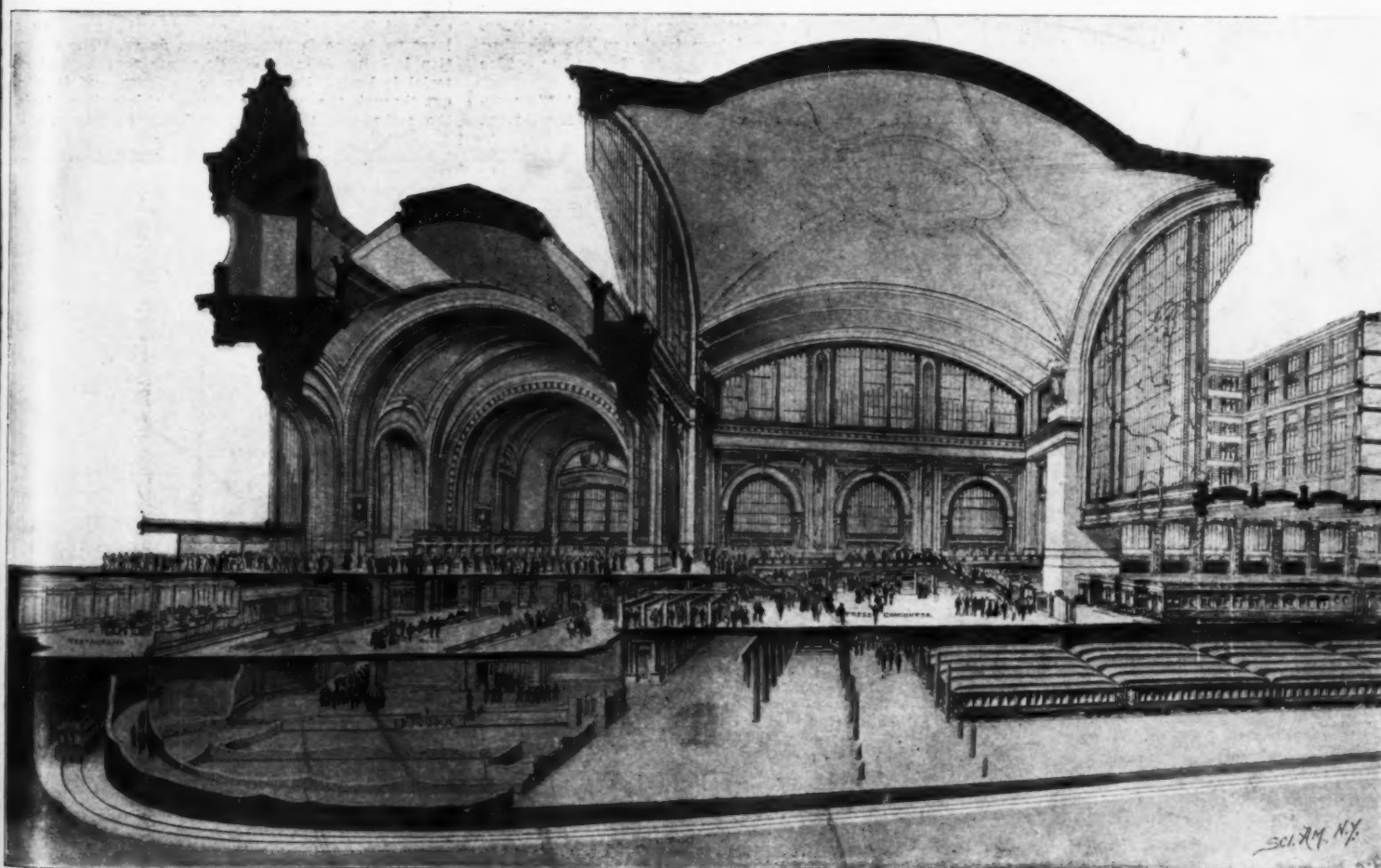
Scientific American and Supplement, \$7 a year.



Frontage on 42d Street, 300 feet; on Vanderbilt Avenue, 650 feet. Height to cornice, 75 feet.

THE NEW STATION AS IT WILL APPEAR FROM THE CORNER OF FORTY-SECOND STREET AND VANDERBILT AVENUE.

Warren & Wetmore and  
Reed & Stem, Architects.



Restaurant.  
Suburban Loop.

Ticket Lobby, 90 x 300 feet.  
Waiting Rooms.

Grand Concourse, 160 x 470 feet, 150 feet high.  
Suburban Concourse.

Express Tracks,  
Suburban Tracks.

LONGITUDINAL SECTION THROUGH THE NEW GRAND CENTRAL STATION, NEW YORK, SHOWING THE TWO TIERS OF TRACKS.

ELECTRIFICATION OF THE NEW YORK CENTRAL'S TERMINAL LINES.

# THE ELECTRIFICATION OF THE NEW YORK CENTRAL'S TERMINAL LINES.

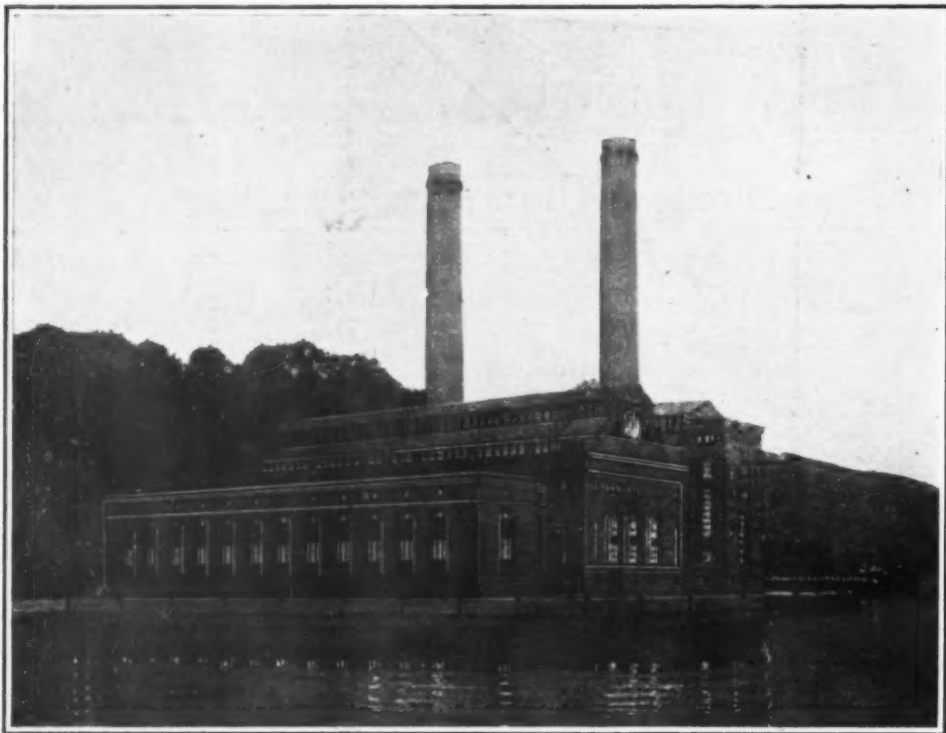
In the history of all improvements in the arts and sciences we would have to search long to find a case where such an important forward step was taken as

The change which is being made will include some thirty-four miles of the main line to Croton on the Hudson River; twenty-four miles of two-track road, known as the Harlem Division, extending from the terminus to White Plains; and the whole of the great station and terminal yard, which is now in the course

to the full width of Park Avenue—140 feet. In order to enable the turnouts to be made without interference from supporting columns, a massive steel truss has been erected at this point for carrying the roof of the tunnel. Provision against accident at these turnouts is further secured by imbedding the lower half of the columns in continuous concrete walls. It is expected that if a derailment should at any time occur, these walls will serve as a shield to protect the columns, and also to prevent the telescoping or serious wrecking of the cars. The 140-foot excavation will provide width for ten parallel tracks, which will be continued down to Fifty-fifth Street, where they will open out into the main yard, and occupy the space from Lexington Avenue to a line 100 feet east from Madison Avenue to Forty-third Street, and thence to Forty-second Street the station ground will be bounded by Vanderbilt Avenue on the west and for a shorter distance by Depew Place on the east. After the station yard has been completed, all the cross streets from Fifty-seventh Street to the north face of the terminal station will be restored, and a driveway will be formed on each side of Park Avenue. From these streets and driveways it will be possible to look down upon the upper deck of the terminal yard. Ultimately, however, it is likely that the blocks bounded by these streets will be covered by buildings, thus entirely shutting in the station yard. Provision for the footings of these buildings will be made during the construction of the terminal.

The tracks of the main or upper yard begin to drop at Fifty-seventh Street, until they reach a level 15 feet below the grade of the present tracks. This level is continuous over the whole of the yard and through the terminal building. At Fifty-third Street the two outermost of the ten tracks begin to drop on a two per cent grade to the level of the lower deck, which will be 40 feet below street grade. The excavation for the lower level for suburban trains will not extend over the full width of the yard throughout its entire length. This level will be provided in the station with fifteen parallel tracks, and in the station yard with twenty-eight tracks. The lower deck excavation will be carried for its full width as far north as Forty-eighth Street, whence it will narrow gradually to the point where it meets the two outermost suburban inclines, that lead up to the common level in the tunnel.

The method of carrying on the work in a manner not to interfere with existing traffic consists in first establishing a temporary station on the easterly side of the yard, which is already excavated, equipping the first floor of the Grand Central Palace as a waiting room. The suburban traffic will first be moved to this temporary station, thus vacating the easterly half of the present yard for construction work. When this portion is excavated, the express service, which up to this time will be handled in the westerly side of the present yard, will be moved to the new level, thus vacating the remainder of the present yard so that the excavation can be completed and the new station built. The lower level construction will be carried on conjointly with that of the main yard, or at least as far as it is possible to do so. The excavation is being done chiefly by steam shovel. The material is loaded directly on to flat cars, and is taken out through the tunnel, and used chiefly in widening the embankment of the New York Central roadbed



EXTERIOR OF YONKERS POWER STATION.

In the case of the sweeping change from steam to electric traction which is taking place on the New York Central Railroad over its terminal lines in New York city. It is true that this step is only one of many by which electric traction has grown from the first crude attempts to its present splendid achievements. But the significance of the New York Central improvement lies in the fact that the practical application of the art will here receive an impetus, will take a forward step, greater perhaps than any single advance that has been made in the course of its whole history. From the running of comparatively light street cars at moderate speeds of from 10 to 15 miles an hour, to the handling of heavy express trains weighing from 300 to 900 tons at speeds of from 40 to 60 miles an hour, is a far cry; and the New York Central Company is to be congratulated on its foresight and courage in applying electrical traction on a vast and sweeping scale.

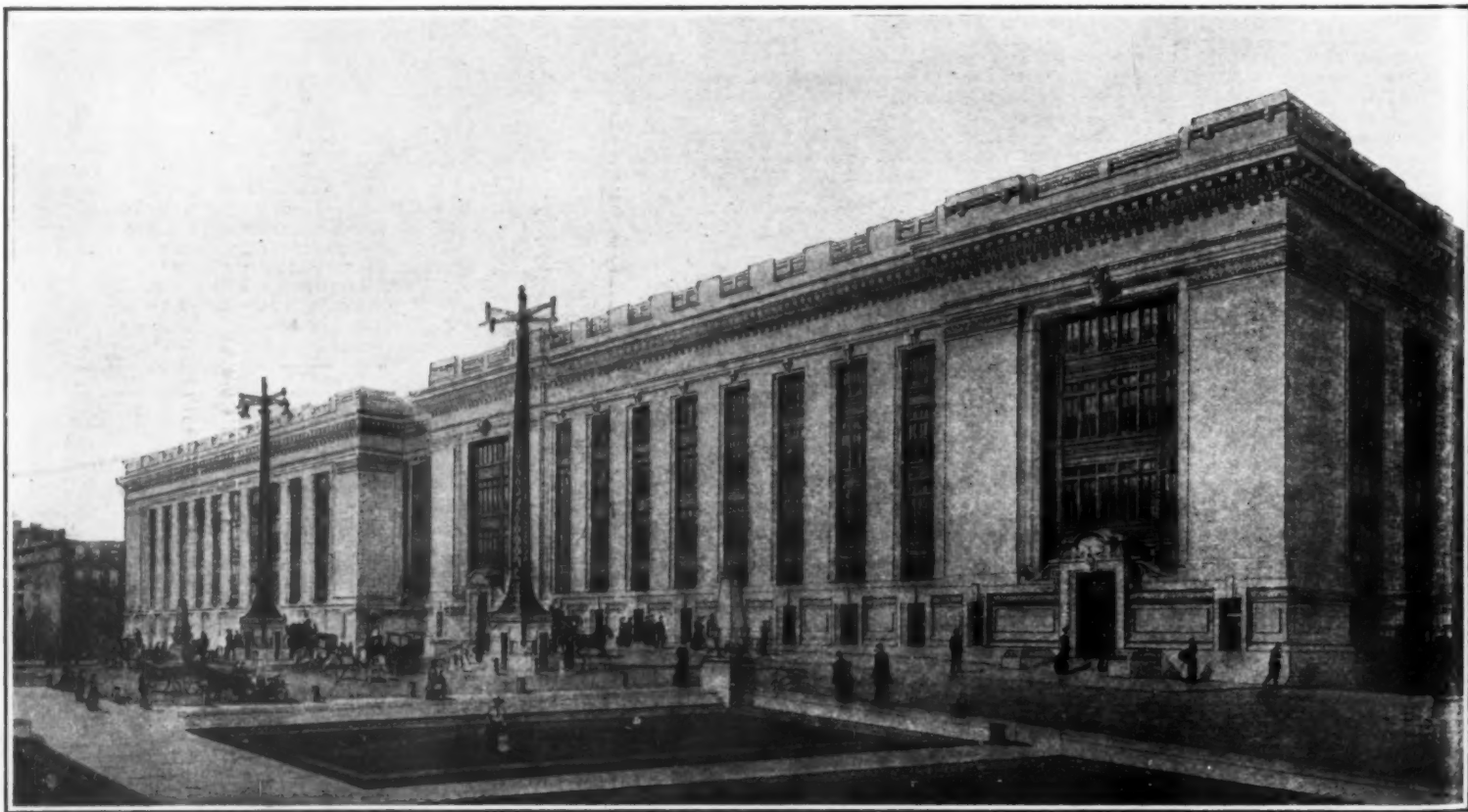
of construction at the site of the present Grand Central Station.

In this article it is our intention to summarize the stupendous work of electrifying the terminal lines of the New York Central.

## GRAND CENTRAL STATION AND TERMINAL.

The plans developed for the new Grand Central terminal have three salient characteristics: 1. A great increase of size, enabling all the facilities essential to a terminal to be much enlarged. 2. The provision of two tiers of tracks in the station and yard, one tier for through trains and the other for suburban trains. 3. The use of terminal loop tracks on the suburban tier, to facilitate loading and unloading and to reduce the terminal wait of the trains.

The new station yards will commence at Fifty-seventh Street, where the tunnel has been excavated out



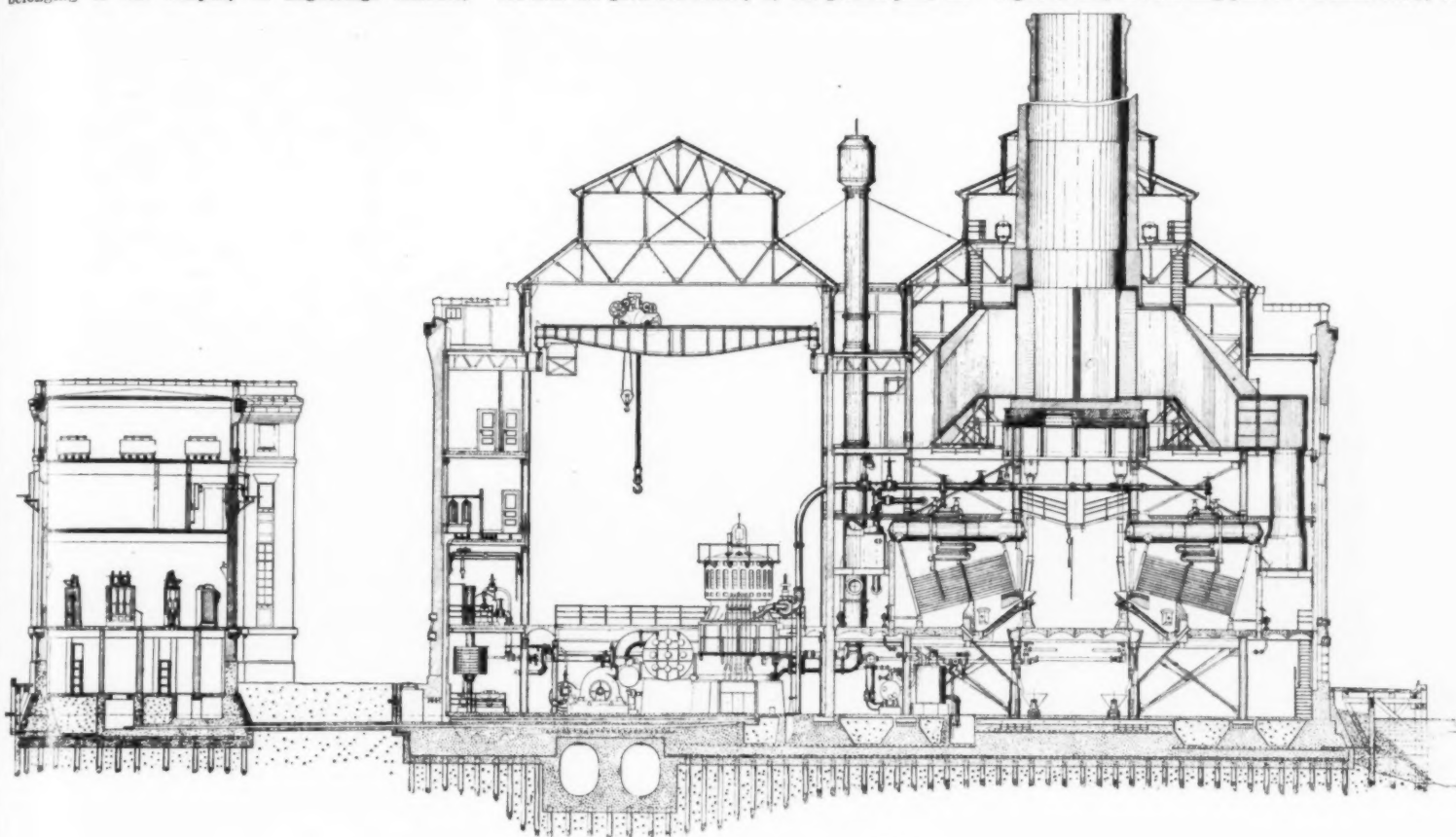
GRAND CENTRAL STATION, FORTY-FIFTH STREET ELEVATION.

THE ELECTRIFICATION OF THE NEW YORK CENTRAL'S TERMINAL LINES.

sufficiently to provide for a fourth track from New York to Croton, a distance of 34 miles. There is also sufficient material for adding, if desired, a fifth or sixth track roadbed, while a large amount of the material has been used for filling in fifty or sixty acres of land belonging to the company at Highbridge marshes,

and express buildings, will cover the blocks lying between Vanderbilt and Lexington Avenues from Forty-fifth to Forty-third Street, inclusive, and the block fronting on Forty-second Street between Vanderbilt Avenue and Depew Place. The main architectural features are governed strictly by the ground plan, the

massive arches, each 33 feet wide and 60 feet in height. On entering, the passenger will find himself in a vast ticket lobby, 90 feet in width by 300 feet in length. In the center of this building will be a long, oval structure, containing the ticket offices. To the right of this, and forming part of the main lobby, will



SECTION THROUGH THE YONKERS POWER STATION.

ground which will be very serviceable for storage purposes.

The new terminal covers, in addition to the space of the old terminal, about twenty acres of ground. The buildings on this ground, residences, stores, apartment houses, churches, and hospitals, to the number of nearly two hundred, have been removed, and excavation for the new terminal has been in progress since August, 1903. The work is necessarily slow, because the full amount of train movement must continue during the reconstruction.

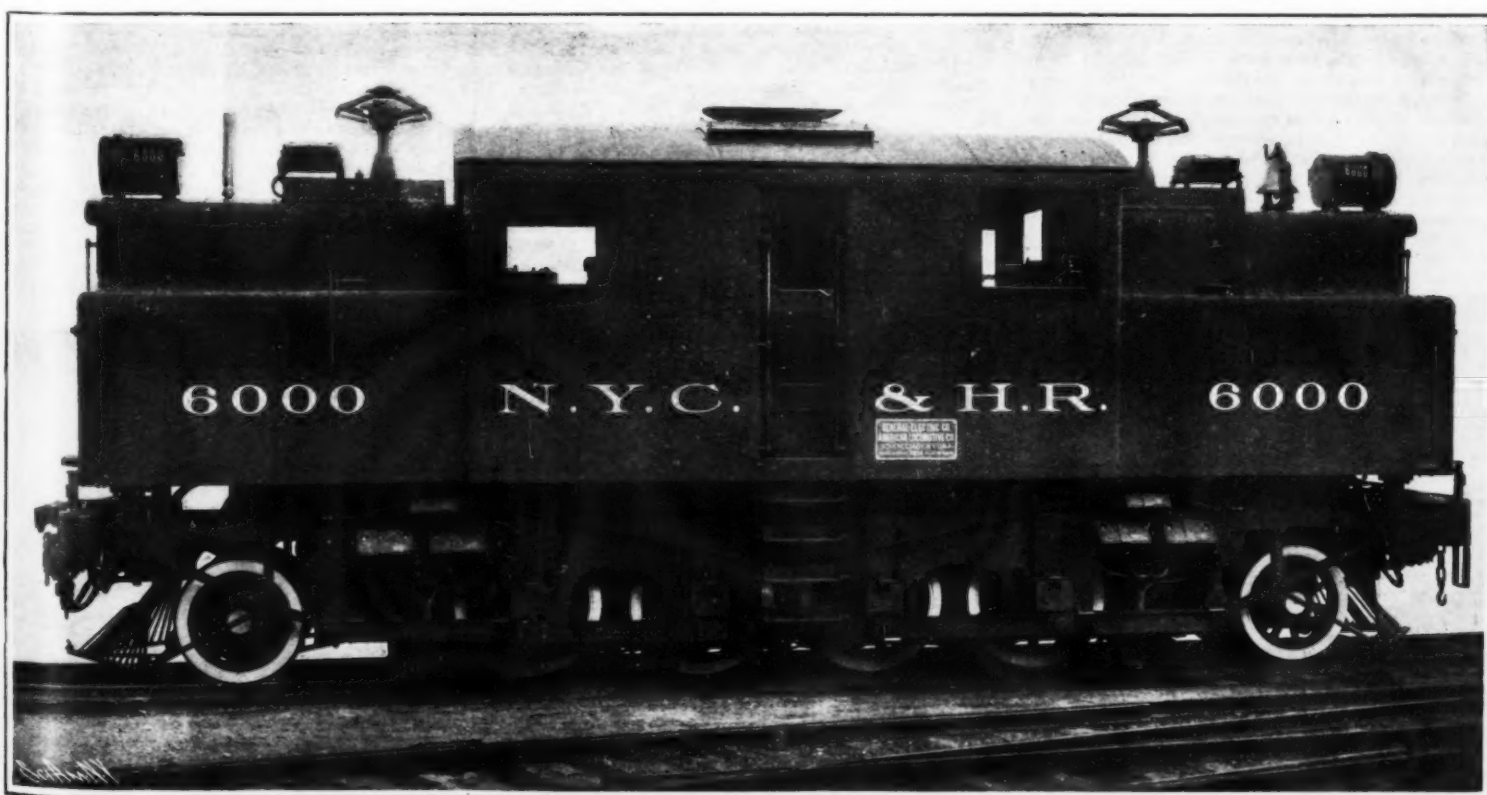
#### THE NEW GRAND CENTRAL STATION.

The new Grand Central Station proper, together with the general offices of the company and the post office

dominant architectural elements being determined in every case by the structural engineering necessities of the station. The southerly facade will stretch for 300 feet on Forty-second Street, and the westerly facade will reach for 680 feet on Vanderbilt Avenue. The building will extend 625 feet on Forty-fifth Street, 400 feet on Lexington Avenue, 275 feet on Forty-fourth Street, and 260 feet on Depew Place. The southerly half of the building incloses the station proper, this portion extending as far north as the northerly side of the great arched roof, seen in the perspective view. The northerly part of the building is given up to the offices of the company.

The imposing main entrance to the station on Forty-second Street is composed architecturally of three

be the outgoing baggage room. On the opposite side of the lobby the passengers will leave the ticket lobby through three main arches, corresponding to the entrance arches, and enter a broad gallery, which runs around three sides of the grand concourse. The ticket lobby and this gallery, it should be understood, are at street level. From the gallery, passengers will descend by four broad staircases, each 25 feet in width, to the floor of the grand concourse, which, by the way, is considerably the largest of its kind in the world. Its width is 160 feet, its length 470 feet, and the height from the floor to the top of the domed roof is 150 feet. The noble arched and domed roof of the concourse will extend entirely across the full width (Continued on page 25028.)



Weight of electric locomotive, 95 tons. Weight on drivers, 69 tons. Tractive effort, 32,000 pounds. Horse-power, 3,000.

THE NEW ELECTRIC LOCOMOTIVE FOR THE EXPRESS SERVICE OF THE NEW YORK CENTRAL RAILROAD.

THE ELECTRIFICATION OF THE NEW YORK CENTRAL TERMINAL LINES.

## LATHES FOR THE AMATEUR.

The choice of a lathe is akin to that of a microscope. You can spend the money on the lathe, or on the microscope body only—that is, without accessories, or you can get a lot of these thrown in at about the same cost as that of a plain tool, or instrument. Anyone of experience will adopt the first-named method—will buy the bare lathe, or plain instrument only, getting the best possible article for the money, and add the ac-

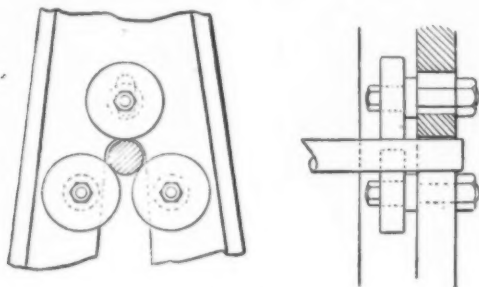


FIG. 1.

cessories from time to time later. When one sees the wealth of chucks which form the equipment of some amateurs, or the numerous object glasses, eyepieces, stage fittings, etc., of some microscopists, these, it should be remembered, are almost always the accretions of many years. The temptation which the inclusion of a lot of lathe fittings offers to the amateur is one to be resisted. They are not the main points to which attention should be chiefly directed when buying a lathe.

The principal points to be settled are: First, the suitability of the lathe to the class of work that will have to be done upon it, and afterward its capacity for extended usefulness. Questions of height of centers, length of bed, types of slide-rests, of headstock, and poppet details arise in these connections. And behind all, and as important as any, is the build of the lathe. Nothing good of any kind can be done in a light, flimsy machine. Even though it be but of 3 inches or 3½ inches centers it must be rigidly built in proportion to its size, and the same remark applies to all machine tools. A common sight in our workshops is a massive milling machine of several tons weight driving a cutter often not bigger than 1½ inches or 2 inches in diameter. So with lathes: everyone knows that if these are to do logging, they must be massive. But for light and delicate work also rigidity of design is none the less essential if steady cutting, free from vibration, is to be done. Neither is there any durability in wearing parts which are slenderly proportioned, because the small areas in contact, whether those of mandrels or slides, become worn immediately. In this point, too, many lathes built for amateurs are found wanting.

The first point, then, is to select a solidly-built lathe of suitable centers and length of bed for the work in hand. Generally, the range of centers is included between 3½ inches and 6 inches or 7 inches, if power driving is available. The average length of bed in feet equals the centers in inches—that is, a 5-inch lathe has a 5-foot bed as a standard length. But the lengths are increased when desired. These lathes are obtainable at prices ranging anywhere from below £10 up to £100.

From the point of view of rigidity, the bench lathes, when of small size, have some advantage over those which are mounted on standards. In light, cheap lathes the standards or legs are generally much too flimsy, and the bed sways on them. As this is not conducive to good work, it is better to bolt the bed directly down to a bench, with short legs or blocks intervening. Only then the lathe is not self-contained, but the treadle arrangements require a separate rig-up. Bench lathes are especially suitable when power-driven.

A lot of questions now arise at once. The primary one is that of the method of operation of the slide-rest—whether it shall be adjusted longitudinally by hand only, or traversed by rack and pinion by hand, or

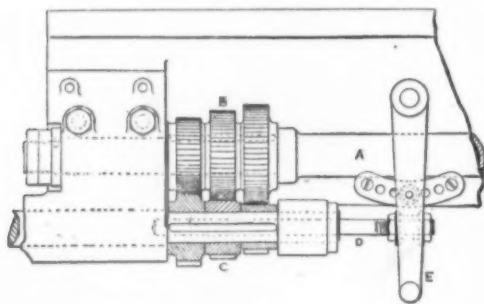


FIG. 2.

whether self-acting by rack, or with lead-screw and change wheels, or either at will. The price is very largely determined by these points, apart from the further questions of quality of workmanship. Each man, of course, should know his own requirements best; but it must be remembered that the limitations to the range of work which can be done on lathes destitute of screw-cutting arrangements are great. It is, therefore, better in almost all cases to spend the money available on a lathe of this type, destitute of adjuncts,

than to have one of plain hand type with numerous accessories.

The back shaft is omitted from many screw-cutting lathes, thus throwing all the work of self-acting feeding on the lead-screw. It then becomes a question for consideration whether the price of the back-shaft shall be saved at the expense of wear on the screw, beyond that of its own legitimate function. Using long protecting covers, wiping it frequently, and oiling it, and the nut, will insure its preservation for a very long time. This is not the only alternative, however, since a large number of lathes have a splined or key-grooved lead-screw encircled by a worm, the spline being used for feeding and driving the worm, which further drives a train of gears. The screw is then reserved for screw-cutting. Some object to the groove in the screw, but it is nevertheless adopted on many lathes of American type. In another group two screws are fitted, one being used for feeding, and the other for screw-cutting.

An automatic cross-feed put in by a friction clutch is a useful addition to an amateur's lathe, but, of course, with an increase in mechanism, and in price. All these differences in detail are presented for choice, and what would suit one would not be equally pleasing to all.

In most cases the amateur would do well to select a lathe with a gap. This is of much less value in workshops where there are plenty of lathes, and considerable specialization of tasks, than it is to the man who has but one lathe to do all jobs. In a good design the gap is not, as is often stated, a source of weakness, nor does its bridge fitting give any trouble. Even if there were any force in objections of this kind, the advantages of being able to do large work as well as that between centers would outweigh them considerably. A gap doubles the capacity of a lathe as far as the length of the gap will admit.

The fittings of the driving-crank axes should, except in very small lathes, include a heavy flywheel,

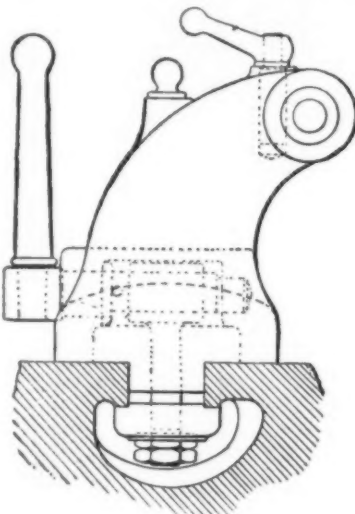


FIG. 3.

counterweighted, to balance the cranks; chains driving to the cranks, and roller bearings, Fig. 1, instead of pivots or centers which are, however, very well for light types. Both belt, or cord pulleys, and flywheels should be turned on edges and rims.

The question of cords or of belts for driving is one that almost settles itself. Pulleys for cords are seldom fitted to lathes of over 4-inch and 4½-inch centers. Over the latter size, belts are the proper thing to use. Personally, the writer prefers belts in all cases from the smallest upward, as driving more reliably without slip.

Another question is that of an overhead. This is invaluable in any case, and quite essential when the intention is to perform all kinds of work in a lathe alone, such as gear-cutting, tap-fluting, and various milling operations. This, with a wheel-cutting attachment, is an expensive addition, but may generally be left over to be purchased later. Only the type of lathe should be selected with that ultimate object in view, the principal essential point being the inclusion of a division plate to the headstock, either at the time of purchase, or of a class of headstock to which it can be conveniently added subsequently. The same remark applies to the tangent wheel and worm on the back of the cone pulley.

At this stage the rivalry of the older English types and that of the newer ones, built much after American models, comes up. If an overhead is wanted, it is essential to take the first-named model. If an overhead is not wanted, the latter models with lead-screw and feed-rod in front have some advantages over the other. Very many English firms now make this design, built so far after American types, but combining most of the good features of the English design of lathe. In this combination form the best lathes of the present day are built.

It is not so essential to an amateur's lathe that minor labor-saving economies should be embodied, as it is in the case of lathes that have to be used in manufacturing shops. But it is at least desirable. When, therefore, lathes can be purchased in which changes in rates of feed can be made by simply moving a lever, and without stopping, it is just as well to select them. A device of this kind, from one of Birch's lathes, is

shown in Fig. 2, where the guide-screw A is fitted with a series of wheels, B, C, for quick changing from roughing to finishing cuts. Either of the wheels C can be put into engagement by the sliding of the rod D by the lever E, which is locked in any one position by the spring plunger. This not only saves time otherwise spent in altering the change gears, but also permits of three different pitches of screws to be cut with each set of gears on the swing frame.

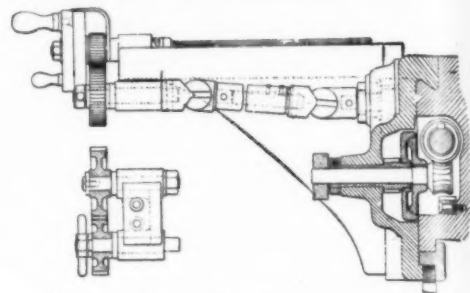


FIG. 4.

Sometimes it is wise to select a lathe in which the feed-rod and lead-screw are both in front, and with automatic stops and throw-out. This arrangement is advantageous when large numbers of similar pieces have to be turned and screwed of exact lengths up to shoulders. It is also sometimes handy to have lead-screw and feed-rod connected, so that the same change-wheel train can be used for both. It is convenient to be able to feed in thousandths of an inch precisely, and without measurement, and this is embodied in the rest slides of many lathes. In Birch's lathes, the cross slides are fitted with a micrometer with two readings; that on one edge reading to one-thousandths, that on the other to the ordinary subdivisions of the inch. These and other refinements cost money; but it is just as well to have them, and others, when a considerable amount of money can be spent.

In the selection of the rest, the preference of the English compound type, rather than the American type, or that with the rise-and-fall device, is to be recommended—if there were no other reason than that because it permits of heavy and deep boring, such as cannot be done on the latter. And, besides this, there is the fact that the longitudinal feed of the American type can only be done by moving the entire carriage, which does not lend itself to delicate movements, while the English has the advantage of permitting of minute feeds by hand, operating the tool slide. The four bolts on the latter, or the clamping-plate in the smaller sizes, are immensely better in several respects than the little slotted tool-post of the former. The English rest is also more adaptable to the employment of the various tool-holders, so dear to the amateur, than the American is. Also, a piece of work can be much more readily bolted down for boring, or drilling, or milling, etc., on the English carriage than on the other kind; and the American rest is almost always too weak and thin to stand strong bolting—in fact, one is more likely to bolt the slide to the work than *vice versa*, in which case the slide is distorted. This is partly due to the necessary thinness of the American slide, caused by the raised vee; while the English type with flat bed allows a greater thickness of metal to be put into the saddle at a very vital part. When selecting a rest, always have the base graduated into degrees for turning tapers and boring-in at definite angles. Friction or clutch feeds should be embodied for throwing the sliding and surfacing motions in and out instantly. It is advantageous to be able to run the cross slide off the carriage at the back, leaving the latter clear for bolting work down to for boring.

The question of a lathe carriage having an elevating rest fitted to the front of the carriage is one that would often be wisely decided in the affirmative. It depends, however, on the class of work to be done; thus it is a very valuable fitting in conjunction with the overhead. In such cases the lathe is modeled specially to suit the

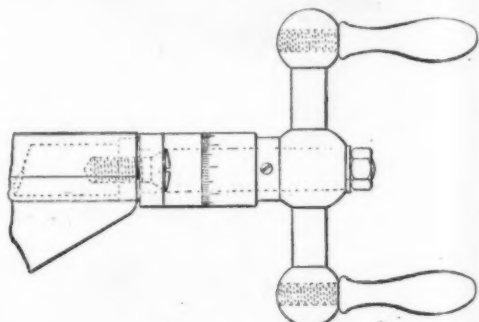


FIG. 5.

rest, the heads being curved over toward the front, as in Fig. 3, and the carriage having a vertical face, Fig. 4, to receive the slide. This does not, therefore, belong to that class of fittings which can be added to a common lathe. Its principal utilities lie not in turning, but in milling, and in boring articles attached to the rest, since the height of these can be adjusted within a range of several inches without the bother of using packings.

Fig. 4 illustrates some of the main features of the

4-inch lathe of this type, as made by G. Birch & Co. The rest is carried on the knee-bracket A, which has two ribs, and a vertical movement of 4 inches by hand-wheel below, not shown, with a micrometer reading to thousandths. The surfacing motion of the cross slide, moving on A, is imparted through the telescopic shaft with universal joints, to allow for the varying heights of the vertical slide. The worm-gear and friction-cones, seen below the lead-screw, impart a very slow traverse to the carriage, working through further gears not shown. Readings can be taken in thousandths of an inch.

A secondary advantage of this type lies in the design of bed, which can be adopted with a front slide-rest. The lead-screw is inclosed and protected, and as all cutting lies outside the bed, no chips can fall on it or on the screw. The vee'd fitting above, with rounding edges, and the square gib below are a happy combination. A rest of this kind can also be run back past the poppet out of the way, when a hand-rest has to be used or plain drilling against the poppet is to be done.

The double, or balanced, handles for the feed-screws of slide-rests, Fig. 5, should be fitted much more frequently than they are. They are more readily felt and manipulated than a mere crank-handle, working on a square, which latter also wears slack in a short time. The same illustration shows the micrometric divisions on the boss, and the plate thrust to the screw, by which both directions of thrust are taken at the one end, leaving the other end of the slide open, so that the rest may be run right off instantly, without disturbing the thrust arrangements of the screw.

The design of the fast headstock is a matter of equal importance with that of the rest. Its design is modified by the arrangements of the lead-screw, and back shaft or feed-rod, and by the fitting of an overhead. Other things being equal, a lathe in which reversal takes place within the headstock by the simple movement of a lever should be preferred to the outside reversal. A friction back gear is of much value as a time-saver, but this is not as yet fitted to any strictly amateur's lathe. It would be of little advantage, perhaps, for a treadle lathe, in which stopping is easy and natural; but for power-driven lathes it is a decided advantage, as the gears can be thrown out without stopping the lathe. There is one item, however, which is so valuable that it should determine one's choice, and that is a hollow mandrel. In recent years an immense number of English lathes have embodied this design. Fig. 6 illustrates a head of this design by G. Birch & Co. The convenience of being able to put in a bar from the back, turn, and cut off in successive lengths instead of preparing a number of short lengths, and chucking each separately, outweighs any disadvantages due to the absence of the bridge at the rear and the thrust pin, which latter is done away with, and an even better form of thrust substituted in modern lathes. A hollow spindle involves larger bearings, and this is a benefit, because more durable and steady than small bearings. The hollow spindle also permits of the use of split chucks and plungers.

The question of taking up end-thrust is more simple of solution in solid mandrels than in hollow ones. In a solid type, either a pointed tail-pin is used, or a direct end-thrust taken by the bridge-pin, with or without washers. In the hollow form, some form of collar or a ball race is essential. In Fig. 6, the end-thrust is received on the front and back of the collar A. Its wear being taken up by the screwed collar B and lock-nut C. By this arrangement the adjustment of the mandrel is not altered if the latter gets warm while running. The friction washers and surfaces are hardened, and they run continuously in oil in the chamber.

Ball thrusts are fitted to a large extent in small lathes, and they answer admirably for this purpose, making the operation of drilling very much easier.

ing of the headstock. The latter position affords more security from access of dirt and cuttings than at the front, where the turning is close to the bearing; but this may be compensated for by adequate guarding of the bearing with overhanging flanges. Both types of grooves are used for the balls—the vee'd and the concave, and another form shown in Fig. 7 is adopted to a certain extent. This shows the thrust taken before the rear bearing, one collar being checked into the bearing slightly, and the other forming one of the nuts which serves to hold the back-gear pinion in place, both wash-

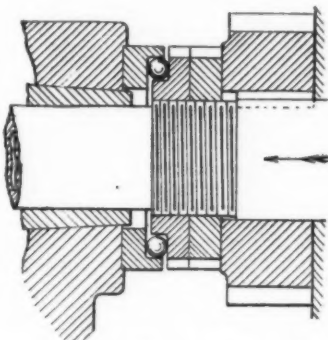


FIG. 7.

ers being of course hardened and ground. Another plain collar at the back of the bearing keeps the mandrel from endlong motion.

The question of back-gears of finer and coarser pitch for first and second motion-wheels need not influence one's choice. In theory this is the proper arrangement, but in practice it counts for little or nothing. A more burning question is that which concerns the arrangement of change-wheels, whether the time-honored train with the swing-plate, or the nest system, of which so much has been seen in recent years. I do not know that these are yet fitted to any so-called amateur's lathe; but the nest-gears are included in a good many small lathes which are suitable for the use of amateurs as of manufacturing shops. The objections which have been made to this system on the ground of the rapid wear of the small gears is not borne out by experience; neither would this count for much in light lathes doing light duty only, and, as a matter of fact, these gears are largely fitted to heavy lathes also—not only to lathes but to heavy milling-machines, heavy boring-mills, and other machine tools. What is good enough for these is certainly good also for lathes of 5-inch or 6-inch centers.

The movable poppet is a fitting which English lathe-makers have not until recently, and now only in some cases, made as it should be made. It is decidedly better to have the front edges of the brackets curved inward to clear the handle of the tool slide when working in line with the bed, as in Fig. 8. Yet the symmetrical form retains its place in a considerable proportion of the lathes made now, the exceptions being comparatively recent.

Again, there is no need to retain the screw-bolt for clamping the poppet down, when a cam with a lever answers the purpose as well, besides being quicker and handier. This arrangement is shown in Fig. 3.

Another point is the fitting of the poppet loosely to the bed, the latter having an inverted vee—the Sellers design—so that clamping down the poppet pulls the washer plate up to the vee, and the poppet tongue to one side of the bed always, so that its alignment remains unimpaired, even though the tongue may become a little loose between the shears. This device is

to its embodiment on the score of possible inaccurate central setting of the head, but this is largely a question of the method of fitting the parts. Some English designs of this kind are reliable enough when used with reasonable care.

There is no reason why a known amount of traverse should not be given to the mandrel of the loose poppet, to facilitate exact drillings. Yet it is rarely done. Mr. Milnes does so, cutting the screw with ten threads to the inch, and dividing a disk on the handwheel into ten. Each turn of the handwheel therefore advances the mandrel one-tenth of an inch, and a tenth of a turn moves it a hundredth of an inch. An alternative to this is to divide the outside of the barrel into divisions, like a rule, so that its amount of projection can be seen at a glance. This may be done without difficulty by transferring the divisions from a good steel rule to the poppet barrel, with scriber.

What has been termed, in recent years, the tool-room type of lathe is one that is, on the whole, the most adaptable to amateurs' requirements of a high class. There are differences in the range of functions of these lathes, but the best admit of almost all operations being performed with great precision.

In talking about the design of the lathe, we have not turned aside to consider the materials and workmanship put into them. In the same design and size of lathe the difference in these will sometimes make 100 per cent difference in price, and yet in general appearance there would, to the inexperienced eye, be little to choose between the two. Mere scrape and polish does not carry weight with any practical engineer. The amateur must either seek the opinion of such, or he must go to a firm of repute, and pay at least a reasonable price. But there are certain points which have to do with design as well as with price.

Even though the usual tests which are applied to lathes give satisfactory results, this does not guarantee the permanence of those results, since soft materials and indifferent fitting induce premature wear. It is to minimize this wear that good firms put tough materials into beds, heads, spindles, and bearings, and spend more time over the mutual fitting of parts than the cheaper firms do. Akin to this is the proper hardening of spindle necks, or the selection of a very tough and hard steel if hardening is not attempted, as is frequently done when steel necks run in gunmetal or phosphor-bronze bearings. If coned steel necks run in steel bearings they are very liable, and almost certain, to seize if not hardened and ground properly and coned correctly, and the thrust-pin suitably adjusted.

Fig. 6 appears at a casual glance like an ordinary headstock. Yet it differs in several important particulars from the cheap-lathe style. The hollow spindle has the bearing necks hardened and ground, and the hole for the coned center is ground after the spindle is assembled in its bearings. The same method is followed in fitting the loose poppets in Figs. 3 and 8. The spindle bearings of the headstock are of hard phosphor-bronze, split, and coned on the outside to permit of taking up wear, which is effected by the nuts *a a*. This is a variation from the older practice of fitting spindles in steel coned bushes; but there is no doubt that the bronze bush will ultimately drive out the steel one from use. The latter is more costly, and if not made excellently will give much trouble, while, as to wear, a phosphor-bronze bush will last for a surprising time before even any slackness makes its appearance.

The cone pulley is turned inside as well as out; the back-gear pinion is a separate casting fitted to the bore of the cone, with a long boss and key. No spanner is required for locking the front gear-wheel and spindle to the cone-pulley, a sliding stud with milled head being provided for the purpose. Proper provision is made for lubrication everywhere. So, also, mention

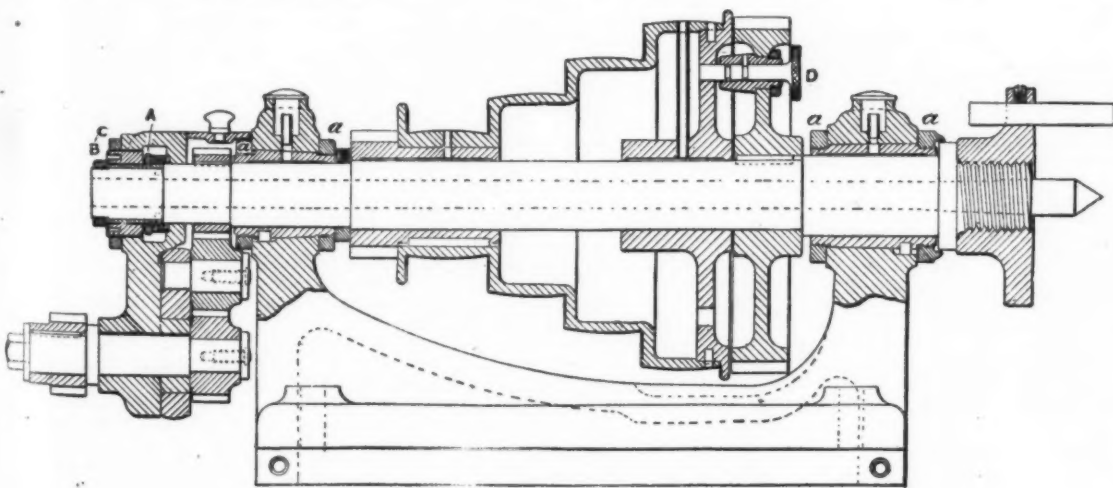


FIG. 6.

There is doubtless little to choose between a well made collar thrust, like that in Fig. 6, and a ball thrust; but the latter will run with less attention, and will stand more dirt, just as in a bicycle it will run for lengths of time without attention, during which a plain bearing would be ruined, if not oiled and cleaned or protected from dirt. There are two alternative positions in which the ball collars are fitted, in front of the front bearing of the headstock, and in front of the rear-bearing

seen in the drawing, Fig. 8, which is one by G. Birch & Co. The poppet is pulled over in the direction of the arrow. The internal screw of a poppet should be prolonged to push out its own center.

The set-over fitting of a poppet for taper turning might be included with advantage more frequently in amateurs' lathes. It is becoming of recognized value in a good many engineers' lathes of English build. It is even more valuable to amateurs. There are objections

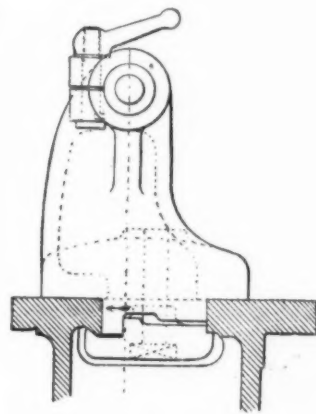


FIG. 8.

might be made that guide-screw clasp-nuts are screwed in solid metal, and have a length of twice their diameter; that gears are cut from the solid, and not merely castings cleaned up with an emery-wheel; that tough qualities of steel are used for screws—and much more, all contributing to make a good lathe, but costing money.

In writing this, nothing has been said about chucks, steadies, cone-plate, and other accessories, which would

only confuse the essential points at issue, and all of which can be purchased singly and subsequently, while, having a good lathe, many of them can be made.

The best advice to an amateur who has a small sum to spend at once on a lathe, is to get the lathe as good as possible, and put up with the lack of chucks and appliances until they can be purchased, or some of them made later. In thus beginning with a small equipment the worker will have to devise many makeshifts, and in doing so he will learn many valuable lessons, which would be lost to him if a complete equipment is obtained to start with. Though this lack of proper tools for the work in hand causes a considerable waste of time, that is not, as a rule, of so much moment to an amateur working for the love of the thing, and he will derive much greater pleasure in gradually acquiring and making up a fine lathe outfit by his own efforts.—English Mechanic and World of Science.

#### THE USE OF GAS FOR POWER AND HEATING.\*

By ERNEST A. DOWSON.

THE subject dealt with in the present paper covers a very wide field, both for inquiry and for application, and in order to keep within reasonable limits it will be necessary to deal more with the general principles underlying such application, rather than merely to record a number of disconnected facts. As, also, I am here dealing primarily with the use of gas, but little will be said about the design of the generating plant itself, which is a matter chiefly of interest to the specialist.

Gas engines have now passed out of the experimental stage and are in use in every-day industry; it is, therefore, needless to make any apology on their behalf. With a few exceptions, chief among which are railway locomotion and marine propulsion, they are performing nearly all the services to which the steam engine has hitherto been applied, and even these exceptions seem destined to come "within the rule" very shortly, if the present sanguine hopes are realized. Looking for the causes of this, we find that the heat efficiency of a modern gas engine is quite 30 per cent, as compared with only some 15 per cent for a good steam engine. Among other subsidiary advantages which combine to turn the scale in favor of gas power may be mentioned the saving of ground space, as well as of fuel, water, and labor. The fact that small gas engines are practically as efficient as large ones is of importance, as also that the engines may be placed at any distance from the generator without loss in transmission, while with steam power such loss is very heavy, so heavy, in fact, that Prof. Kennedy has roughly estimated it as averaging 10 per cent of the total fuel consumption in ordinary cases.

To be of practical value, however, a comparison between gas power and steam power must include the apparatus which supplies the working fluid, gas or steam, as the case may be. In the one case there is the large steam boiler, with its expensive settings and chimney, heavy first cost, insurance, inspection and upkeep, and last, but not least, its high fuel consumption and stand-by losses. The scaling and attention needed by such a boiler is also an expensive and troublesome matter, especially in districts where the water supply is of a hard nature. In the other case there is the gas plant, which is entirely free from these drawbacks.

It is interesting to note that the heat efficiency of gas plants has now reached practically 90 per cent, and this in quite small installations. For large steam boilers the average efficiency is not more than, say, 70 per cent, which, however, is seldom if ever reached in the case of the smaller units. An interesting comparison of the heat efficiencies of complete steam and gas power plants was given in diagrammatic form in a paper by Mr. J. E. Dowson, published in the Transactions of the Institution of Electrical Engineers, vol. 33, part 165.

The superior economy of gas-producing plant, used in conjunction with a modern gas engine, is shown by the small amount of fuel consumed compared with that required for steam power. For example, a 100 B. H. P. gas engine and plant would consume under 1 pound of coal per B. H. P. per hour, as against 3 pounds for compound non-condensing steam plant of the best type and like power. In ordinary everyday work, however, steam plants consume far more fuel than this, as was shown by an investigation conducted some years ago by the Birmingham Corporation, and referred to by the late Sir Frederick Bramwell. The actual figures obtained ranged from 9.6 to 27.5 pounds per I. H. P., while the average of all the tests came out as high as 18 pounds, and although these engines were probably not all of the most modern type, yet they represent what one frequently comes across.

Turning to the matter of fuel consumption during "stand-by" hours, careful tests have proved that with gas plants this is almost negligible, averaging, in fact, under 5 per cent of the equivalent stand-by consumption with steam boilers. Some interesting figures bearing on this point are given in the paper by Mr. J. E. Dowson previously referred to.

There are other practical advantages incident to the use of gas power, such as greater simplicity of the whole installation owing to the absence of the many accessories required to insure the best results when working with steam. The additional safety following on the elimination of the high-pressure boilers and steam mains is also not unimportant, as this makes it

possible to leave the installation in unskilled hands.

A power station equipped with gas engines and plant has a further advantage in that it can be put to work at full power after much shorter notice than would be required if steam plant had been employed. This point is of much importance in the case of public electric lighting, etc., as sudden unforeseen "peaks" frequently occur, owing to fog or other causes.

Proceeding to describe the properties and manufacture of those gases which lend themselves economically to industrial use on a large scale, I will confine my remarks to the most important, omitting all the explosive vapors from oils or other volatile liquids, etc., which, while useful in certain applications, prove too expensive for ordinary purposes.

"Coal gas," or as it is frequently called, "town gas," originally the only fuel used in gas engines, is still so employed, though chiefly for the smaller powers. This gas is produced by the destructive distillation of coal in closed retorts. It has, however, in many cases been enriched for the purpose of increasing its illuminating power, and has also passed through an elaborate system of distributing mains, both of which assist in making its cost very high. Although this cost has been somewhat reduced since the introduction of the process of admixture with carbureted water gas, there is no immediate prospect that the supply from the public lighting mains will be obtainable at rates which will compare in economy with the use of self-contained gas plants on the users' premises. The heating value of town gas varies in different places from 500 to 700 B. T. U. per cubic foot. Here I would impress upon the users of coal gas for engine power the importance of knowing the heating value of such gas, or the number of cubic feet required to develop each horse-power, as a mere knowledge of the cost per 1,000 cubic feet of gas is nowadays of little comparative value.

An average analysis of coal gas is here given, which refers to the gas without any admixture of carbureted water gas. The percentage addition of the latter varies in different places, as there is no fixed rule on the point, but probably 20 per cent of the total volume is somewhere about the figure usually found in English practice.

	Per cent.
Hydrogen .....	47.0
Carbon monoxide .....	9.0
Marsh gas (C H <sub>4</sub> ) .....	34.0
Benzene vapor (C <sub>6</sub> H <sub>6</sub> ) .....	1.2
Ethylene (C <sub>2</sub> H <sub>4</sub> ) .....	3.8
Carbon dioxide .....	2.5
Nitrogen .....	2.5
	100.0

For intermittent working on a moderate scale, the use of coal gas from the public mains is, of course, very valuable for application to industrial processes, as in these cases it is not usually worth while to start up a gas generator of any kind. There are also some classes of heating work for which coal gas is peculiarly well fitted, such as the brazing of small jewelry parts, etc., where a narrow, concentrated flame of high temperature is called for.

"Coke-oven gas" is evolved incidentally in the manufacture of metallurgical coke, which operation has hitherto been performed in simple ovens of the "beehive" pattern. At the present time, however, newer types of oven are being introduced, as the gas contains many valuable by-products, and it is becoming general to recover some of them, using the heat of combustion of the gas to perform the coking operation in a closed muffle, simultaneously distilling off the volatile constituents of the coal. Frequently there remains a surplus volume of inflammable gas which is available for outside purposes, such as the driving of engines, and the composition of this gas somewhat resembles that of a weak "town" gas. The author learns from Mr. John W. Hall that the latter has recently inspected some installations of this kind. Mr. Hall was also good enough to afford some general information with reference to this, from which it appears that from 50 to 80 per cent of the gas evolved is consumed in the coking process, leaving the balance available for motive power, under favorable conditions. The calorific value of the gas in these cases was from 360 to 420 B. T. U. per cubic foot.

Passing to a consideration of the cheaper gases, we will first notice "air gas," which has hitherto been generally known as "Siemens" or "producer" gas. This term "producer gas" seems now to be applied somewhat indiscriminately to any gas not made in closed retorts, although the various systems in use are widely different, as also are the gases resulting therefrom. Possibly it may be found better to adopt some clearer terms in the near future, which will be more truly generic than the one just spoken of. At the same time, the rapid popularization of special gases, due to the simplification of the plants, commonly spoken of as "producers," may lead eventually to the transfer of the term.

Air gas is produced by passing a stream of air through a considerable depth of fuel. The oxygen in the air combines with the carbon in the fuel to form, first, carbonic acid, which is then reduced to carbonic oxide by further combination with carbon in its upward passage through the fuel; the nitrogen, also in the air, is not changed in any way, and merely dilutes the other constituents. The gas therefore consists essentially of a mixture of carbonic oxide and nitrogen, but there are always present small per-

centages of other gases, these chiefly being carbonic acid which has escaped reduction, also hydrogen and marsh gas, which are liberated by the action of heat on ordinary fuels. This process has been in use for many years for the supply of gas to furnaces, and was adopted by the late Sir William Siemens in conjunction with his regenerative furnace; but such gas is very weak for driving engines, and it is also inconvenient to manufacture on account of the excessive temperature developed in the generators, which suffer severely from this cause.

Air gas is also found as a waste product from the iron blast furnaces, where it is produced incidentally to the heating of the iron-stone. Until recent years this gas was only used for heating the blast for the furnaces and for raising steam in large boilers, while the greater portion of it was blown off entirely to waste.

"Blast-furnace gas" is now in many cases being utilized for driving the gas blowing engines, but great care has to be taken in washing the gas as it contains much dust and grit. Apart from this inherent drawback the supply is not very constant, and the heating value of the gas varies, say between 90 and 120 B. T. U. per cubic foot. For this reason it is not possible to mention any exact standard composition for blast-furnace gas, but the following analysis may be of interest. It represents the gas obtained from the furnaces at the Sheepbridge Ironworks, Derbyshire.

	Per cent.
Hydrogen .....	6.8
Carbon monoxide .....	23.0
Marsh gas (C H <sub>4</sub> ) .....	1.4
Carbon dioxide .....	9.0
Nitrogen .....	59.8
	100.0

Where available, it is undoubtedly right to use blast-furnace gas in the above ways, seeing that it costs so little. This source of power is, however, only possible at certain large iron works, and does not touch manufacturers in general.

"Water gas" is formed by the interaction of steam and incandescent carbon. The process is an intermittent one. The first operation consists in raising a deep bed of coke to a high temperature by means of a blast of air from a fan. During this period air gas is formed, in the manner just described, and it is generally blown away into the atmosphere to waste. In some instances, however, a portion of the gas is used, by the heat of its combustion, to dry the steam required for the next step, or to raise the temperature of the blast. After the fuel reaches incandescence the air blast is cut off and steam is blown through the fire. The resulting "water gas," which consists chiefly of carbonic oxide and hydrogen, is led away and stored for use. The temperature of the fuel soon falls below that required to produce the reactions, and it is then necessary to repeat the first operation. Where a constant supply of gas is needed it is usual to install the plant in duplicate, each section being then worked alternately. The heating value of water gas varies from, say, 240 to 280 B. T. U. per cubic foot, and the cost of manufacture is from 4d. to 6d. per 1,000 cubic feet.

Water gas is clean in use, and owing to its high flame temperature, coupled with its comparative cheapness, it enables certain special processes, such as steel welding and the like, to be carried out in the most practical way. On account of the intermittent nature of its manufacture, which calls for constant attention, and to the introduction of simpler and cheaper methods of gas making, the use of water gas is confined to such special applications and to its use, after carbureting with oil, for admixture with coal gas. This latter has now become a most important factor in the economical running of a works where illuminating gas is made, but the subject does not fall within the scope of the present paper.

Before passing on, mention might be made of a further method of producing water gas, which is, however, only possible on premises where coal gas is manufactured, or where there is a large range of coke ovens. The system was patented by Mons. Emile Gobbe, and his apparatus is known as the "quenching" producer. Briefly described, there is a vertical gas producer, fitted with a hopper at the top into which the hot coke is emptied direct from the retorts or ovens. A supply of water, in the form of steam or fine spray, is introduced at the base, and passing upward through the coke gradually "quenches" it. During its further upward passage this steam is split up into its constituents, and, combining with the carbon, forms the water gas, according to the well-known reaction  $H_2O + C = H_2 + CO$ . The interesting point here is that the process is a continuous one, owing to the elimination of the necessity for first heating up the coke, with the consequent partial wastage of fuel during this preliminary "blow." It is, however, an essential feature of the system that there shall be a continual, steady supply of hot coke.

Finally we have "semi-water gas." This may be said to be a combination of the previously-described gases, and its very wide adoption shows it to be the most generally interesting from an industrial point of view. It would be out of keeping with the objects of your association to fully review the early history of gas generators. Suffice it to say, therefore, that although several old systems give fairly good results in

\* Abstract of a paper read at the Birmingham Association of Mechanical Engineers.

supplying gas to furnaces, it was not until the invention by Mr. J. Emerson Dowson of his complete plant for making cheap gas, for driving gas engines, that the use of any special gas for engine work was attempted. Its introduction marked the commencement of a new era in the evolution of gas power. Up to this period it had only been economical to use engines of a very limited power, but gaseous fuel suitable for driving engines is now extremely cheap, and in point of size the big commercial gas engine has almost reached that of its steam rival.

An important feature of the Dowson system, apart from the nature of the cleaning apparatus, consists in the blowing in of a continuous supply of air, mixed with superheated steam, through a specially-designed injector or blower. The mixed steam and air pass into the closed ashpit of the gas generator and thence through the bed of incandescent fuel above, which is contained within the firebrick lining of the generator. The resulting gases, chiefly hydrogen, carbonic oxide, and nitrogen, pass away from the upper part of the generator into the cleaning and balancing or storing apparatus. In some of the earlier installations a kind of flash-tube water vaporizer was used, which was fed with water direct from the town mains, although more generally the steam has been derived from a small superheating boiler.

A typical volumetric analysis of Dowson semi-water gas may be given as follows:

	Per cent.
Hydrogen .....	18.50
Carbon monoxide .....	25.25
Marsh gas (CH <sub>4</sub> ) .....	2.00
Carbon dioxide .....	5.25
Nitrogen .....	49.00
	100.00

Its heating value is about 160 B. T. U. per cubic foot, while the inclusive cost of manufacture is from, say, 1½d. to 2½d. per 1,000 cubic feet, varying according to the scale on which the gas is made. For developing motive power in an engine, about 70 cubic feet of gas are required to give 1 B. H. P., and the gas needs, for complete combustion, rather more than an equal volume of air.

The popularity to which plants on the Dowson system have attained need not here be enlarged upon, as they may be included among the standard appliances of a modern works.

Many installations which were put down over twenty years ago are still doing good service, showing that they have a good working life. It will be appropriate to mention that, among the many Midland installations, the Birmingham Small Arms Company's cycle works at Small Heath have been driven by a plant of this type since 1897, the gas being used in a number of engines of various makes, in addition to supplying a battery of hardening furnaces. This installation was so successful that the system has been extended so as to serve the rifle works also. The extension serves a large central electricity station, which at present contains three sets of vertical gas engines, each developing 250 horse-power. The engines are of the British Westinghouse Company's make, and are direct-coupled to 150-kilowatt dynamos. Thus the old steam plant has now been entirely replaced by gas power.

For making gas for driving engines, the best results have been obtained when the fuel is either small anthracite pea or ordinary gas coke, but latterly something has been done in the way of using ordinary hard, non-caking, bituminous coals, which in some districts are cheaper than the former. It must, however, be remembered that a mere comparison of the prices of the raw fuels per ton does not constitute a complete basis from which to compute the relative costs of a B. H. P. hour obtained in any given cases. Fuels other than the two first mentioned have certain drawbacks, especially in plants of average size. The removal of the tar which is found in gas made from any bituminous fuel requires more extensive cleaning apparatus, part of which generally needs engine power to drive it, while the water consumption is increased for the same reason, in addition to which it is distinctly a dirty process. It is a mistake to suppose that any class of slack coal may be employed, even in large installations. All coalfields do not yield fuel which will give good results in gasmaking. Bituminous coals are not of so uniform a quality as are those of the anthracite class, and they will always be more troublesome to deal with than the latter. Some coals are very apt to "hang up" in the generators, which, besides causing troubles in working, inevitably leads to variations in the quality of the gas made. More labor is always involved in the gasification of bituminous fuels, and a certain element of risk is introduced of tar getting over to the engines on occasion. When this occurs much trouble is experienced by the "gumming up" of the valves and other working parts, causing serious delay and loss. Various devices may be adopted for lessening the deposition of this tar. One of these consists in splitting up the tarry vapor into its volatile constituents by passing it through the hottest zone of the fire. This principle may be applied by working the generator downward, an example of which is seen in the "inverted" generator of M. Deschamps. Another method is to "by-pass" the raw gases and circulate them through the whole depth of the fire before letting them go forward. Some ten years since this process was applied in tests by the Dowson Company, and it has certain advantages where

such fuel is used. All these arrangements are, however, somewhat complicated, which is an inadvisable feature in an ordinary factory plant. It is a fact that small and medium-sized installations working with bituminous coal have been found to cause a great deal of trouble, and probably it is wise to look on this fuel as hardly suitable for such cases.

Provided one has sufficient scrubbers and washers there is no obstacle to the use of such bituminous fuel, however, and a notable instance of this is to be seen in the large plants arranged by Dr. Mond. The latter has also designed a very ingenious system for the recovery of sulphate of ammonia as a by-product. This is effected mainly by working at a specially low temperature, and subsequently washing the gas with a stream of dilute sulphuric acid. For working on a very large scale this system has shown good results, but it is hardly applicable to the case of the average user, and it is necessary to select a fuel containing a fair percentage of nitrogen. It should be remembered that not only is it advisable that any power plant should occupy as small a space as possible, but that its parts shall be free from complications, which inevitably call for skilled attention and increase the risk of stoppage. Members of this association are aware that a large central supply station has been erected at Dudley Port for the distribution of gas made on Dr. Mond's system, and the working results will be awaited with much interest. Apart from the recovery of ammonia, the actual process of gas making in this plant is similar to that employed in other systems. The heating value of the gas from these "recovery" plants is about 150 B. T. U. per cubic foot.

Modifications of the original type of Dowson gas plant have been introduced to meet the requirements of smaller users. One of these consists in making the necessary steam in the generator itself, the air being supplied, and the pressure being obtained, by using a power-driven fan or blower. This is applicable in many cases where space is limited, while it also reduces to a minimum the amount of attention needed with small plants.

Again, some years ago M. Benier experimented in France with a small Dowson gas plant, and eventually succeeded in arranging for the engine to draw its supply of gas from the apparatus by means of a pump, without the intervention of a gas-holder. This gave somewhat uncertain results, but latterly the idea has again been brought prominently into notice and the separate gas pump has been eliminated. This type of plant has been brought to a high degree of perfection, as shown by the very high thermal efficiency realized, and already touched upon. In this connection reference may be made to Mr. Dugald Clerk's "James Forrest" lecture, read before the Institution of Civil Engineers last year. He there states that during a six hours' test a 40 B. H. P. Dowson plant showed a working efficiency of 89 per cent. This must surely indicate that we are not very far from finality in this particular direction.

(To be continued.)

#### SILVERING MIRRORS.

In a recent issue of the British Journal of Photography a method of silvering mirrors was published in "Ex Cathedra Notes," taken from the Comptes Rendus de l'Académie des Sciences. This method, by M. Izarn, is a modification of a process recommended by MM. Lumière. As it is spoken of by M. Izarn in very high terms, I was induced to try it, and found it a very valuable one.

Taking the formula as given by M. Izarn, I found it needed some interpretation. The directions are to take a 1 per cent solution of silver nitrate, and convert it with pure ammonia in the usual way. As the units of French measurement are the cubic centimeter for fluids and the gramme for substances which have to be weighed, the equivalents in English weights and measures are 15.4 grains of silver nitrate to 1,700 minims of water. To ascertain the quantity of formalin, M. Izarn recommends an experimental method by adding 7 drops, or more, to 15 cubic centimeters of the ammonio-nitrate solution, and watching the result. Using a good commercial sample of formalin (40 per cent strength), I found that rather more was necessary; but it is evident this must depend upon the strength of the formalin and the size of the drops formed by the dropping-bottle. The one used by me measured 65 drops to the drachm. A few trials led to the following modified formula, using a stock solution of silver nitrate of the strength of 25 grains to 1 ounce of distilled water:

Take 2 drachms of silver nitrate stock solution and convert it to ammonio-nitrate, by adding ammonia drop by drop until the precipitate is redissolved. Add 3½ ounces of distilled water.

In another measure take 80 drops (approximately 74 minims) of 40 per cent formalin.

Pour the solution of ammonio-nitrate of silver into the measure containing the formalin, then back into the original measure, and finally into the dish containing the glass to be silvered. This should be done rapidly, and the dish containing the mirror well rocked until the silvering is complete, which may be ascertained by the precipitation of a black, flocculent deposit, and the clearing of the solution. The actual process of silvering takes about two minutes.

Those who may wish to use the process should ascertain for each fresh sample of formalin the requisite quantity, as described by M. Izarn. Take 1 ounce of ammonio-nitrate solution and begin to reduce the

silver with, say, 20 drops of formalin. If a muddy precipitate be formed, and the process be too slow, add more formalin. If too much formalin be used, the process will be too rapid, but if the quantity be right, the solution will pass rapidly through shades of rose and violet until the black precipitate is formed and the solution begins to clear. Meanwhile a film of silver will be deposited upon the glass and the sides of the dish.

Cleanliness throughout is of the greatest importance. The vessels in which the solutions are mixed should be well rinsed with a solution of bichromate of potash and sulphuric acid, then washed out three or four times under the tap, and finally with distilled water. For cleansing the glass M. Izarn recommends well rubbing with cotton wool, first using acid and then ammonia. Polish afterward with rouge, and rinse under the tap. I found it preferable to dip the glass for a short time in a solution of bichromate of potash, to which a little sulphuric acid was added. The glass was afterward well rinsed for a minute or two under the tap, flooded with distilled water, and dried with a clean linen cloth. A little absolute alcohol was then rubbed on with a soft linen handkerchief, which was immediately rolled into a pad and used for well polishing the surface. The cleaning with alcohol was repeated to avoid risk of failure.

After the mirror has been silvered, hold it under the tap and allow water to flow over it for about three minutes. Rinse it with distilled water, and stand it up on edge on blotting-paper. When it is quite dry take a pad of very soft washleather, spread a small quantity of finest opticians' rouge on a sheet of clean glass, and well coat the pad with rouge by polishing the sheet of glass. A minute quantity of rouge is sufficient. Afterward polish the mirror by gently rubbing the surface with the pad, using a circular stroke.

It will be seen that with this process it is unnecessary to suspend the mirror in the silvering solution, as usually recommended. The mirror is laid in the dish, which is a distinct advantage, as the progress of the silvering may be watched until complete. The film also is much more robust than that obtained by the older methods. This may be judged by the fact that I have just taken one of the experimental pieces of glass, and applied considerable friction with the fingertip, and have been unable to remove the film. This powerful adherence facilitates the polishing, and speaks well for the durability of the film.

In comparing the formula given with that of M. Izarn, it will be seen that I have used a different quantity of silver. My object was to produce a very dense film, so that reflection should be as perfect as possible. But it is possible the quantity of solution may have differed, for no particulars are given by M. Izarn for a given area. For silvering a 6½-inch circular mirror I used about 20 ounces of solution. A small, well-glazed earthenware pan was used for the silvering bath, and, as the bottom and sides were thickly coated with silver, a considerable economy might be effected by using a flat sheet of plate glass, with sides of matchbox wood coated with pitch. A wall of putty would probably answer well also. The cost of the silvering solution being only a few pence, economies of this kind need only be considered where a large amount of work has to be done. Finally, I may remark that the quantity of formalin used is not in proportion to the amount of silver, but to the amount of water used. —P. Everitt, in the British Journal of Photography.

#### ENGRAVING ON DIAMONDS.

ENGRAVING on diamonds can be performed in a very effective manner. It is true a few not very artistically engraved stones were found in India, and a diamond on which the portrait of the King of Holland was engraved was shown at the Paris exhibition of 1878. But the work was imperfectly executed, and the stones looked as if they had been deadened rather than polished. Recently, however, according to the Edelmetall Industrie, the Paris jeweler Bordinet has produced some very beautiful specimens of engravings on diamonds. Among other things, he has made a yataghan having a thin diamond for the blade and a ruby for the handle. Worthy of notice also are a large circular stone on which a penny with leaves is cut, and a knife made out of two diamonds. A very artistic piece of work is a bicycle having two diamonds for its wheels, the spokes of which are represented by lines cut in the diamonds, and the axles by two holes bored through the centers. Another diamond is cut in the shape of a fish, and a very beautiful brooch consists of a scarabæus surrounded by sapphires and brilliants. The most remarkable of all is a ring made of a diamond; the inner surface is polished, and the outer surface artistically engraved. There are also brooches in the form of flies, the wings being represented by thin engraved diamonds; also diamonds with armorial bearings, e. g., shirt-studs and sleeve-links with the Russian arms engraved on them. Formerly only flat surfaces could be polished, but Bordinet has succeeded in polishing concave parts, as for instance the body and tail of a fish and the inner surface of a ring. With his tools he can not only make straight lines, but also model freely. These tools are his own invention, and it is stated that only his son is allowed to use them. They are the result of many years' labor, of fine workmanship, and very difficult to handle. Only within the last few years has it been possible to bore holes in diamonds and arrange them alternately with pearls on a string; this work is now regularly done in diamond-cutting establishments.

(Continued from page 25023.)

THE ELECTRIFICATION OF THE NEW YORK CENTRAL'S TERMINAL LINES.

of the station building, a distance of 300 feet, or from Vanderbilt Avenue to Depew Place; but the concourse floor will be carried westerly under Vanderbilt Avenue for a distance of 170 feet. Back of the concourse, and located under the ticket lobby, will be the main waiting room, which will have twice the area of the waiting room of the present station. Surrounding it will be several retiring rooms, telephone and telegraph booths, and the various other conveniences of a modern station. Back of the waiting room will be a large restaurant, located beneath the broad approach to the station. Across the northerly end of the concourse will extend the customary line of gates admitting to the express platforms. Beyond the gates will be located no less than thirty-four stub tracks, with broad platforms between them, the average width being about 16 feet, extra space being provided, in order to avoid the crowding which is such a troublesome feature under existing conditions. Of these thirty-four tracks, the westerly eight or ten will be reserved preferably for incoming trains, and the arriving passenger, on passing through the gates onto the concourse, will find himself opposite a large cab stand, and with conveniences right at hand for securing his trunk and driving away with it with as little delay as possible. In addition to leaving directly by cab, he has the choice of four other means of exit from the station; for he may pass by a covered walk directly to the Subway, or by a 25-foot stairway to the concourse gallery and so into the main ticket lobby, or he can pass out to Madison Avenue and Forty-third Street by a covered subway, or crossing the concourse, he may leave by another covered subway to Lexington Avenue. It will be understood, of course, that the thirty-four tracks extend the full width of the concourse, the most easterly track abutting on Depew Place and the most westerly on Vanderbilt Avenue, and this, of course, necessitated some careful engineering work in supporting above these tracks the immense weight of the northerly half of the station building, containing the company's offices. Care has been taken to so arrange the supporting columns that none of them shall interfere with the passenger platforms. To recapitulate, it should be explained that the ticket lobby and the gallery are at street level, and the express tracks, the main concourse, the express waiting rooms, and the restaurant are at a level 15 feet lower than that of the street.

The plans for the new station involved, as an absolute prerequisite to success, that the suburban travel should be entirely separated from the express; and it was considered that the best way to insure this was to place the suburban tracks below the express tracks and provide a suburban concourse, waiting rooms, and other conveniences on this lower level. Moreover, it was decided that, with a view to further separating the two classes of travel, separate entrances and exits should be provided, so that the suburban passengers could enter or leave the lower level from the street or the Subway without meeting the long-distance travel. Access to the suburban tracks and station is obtained by gradually depressing the two outside tracks in the entrance tunnel below Park Avenue until they reach the lower level. In the rush hours the suburban trains will pass into the station and around a loop which will extend beneath the restaurant on the express level, the trains passing out again without breaking bulk. Toward the close of the rush hours, alternate trains will discharge their passengers from the series of seven stub tracks, which occupy the train space within the loop and in front of the suburban concourse. Trains will be stored here and in the station yard until the evening rush hour, when they will be switched out into service again. Provision is made at the inner end of the loop for connection direct to the tracks of the Rapid Transit Subway below Fourth Avenue.

The suburban station is provided with a broad concourse and with the necessary waiting room and other conveniences, all arranged on the lower level, and with separate exits both to the Subway and to the street. This station is, to all intents and purposes, absolutely independent of the express station above; although provision is made by means of staircases for communication direct from the ticket lobby and the main concourse to the suburban station.

MOTIVE POWER AND ROLLING STOCK.

Corresponding to the two classes of service, two radically distinct forms of motive power are needed for operation. For hauling fast and heavy through trains electric locomotives of great weight and high speed are required; for suburban service the rolling stock need not be essentially different from that developed on multiple-unit urban rapid transit railways. The motor cars which have been designed for the latter service show, in fact, close similarity to the type of equipment used in the New York Subway and (more recently) on the newly equipped electric lines of the Long Island Railroad. The locomotives, on the other hand, represent a wholly new design, the product of thorough study by the American Locomotive Company and the General Electric Company, both of Schenectady. They are of unprecedented power, have shown satisfactory performance on running test, and promise satisfaction as regards maintenance and durability.

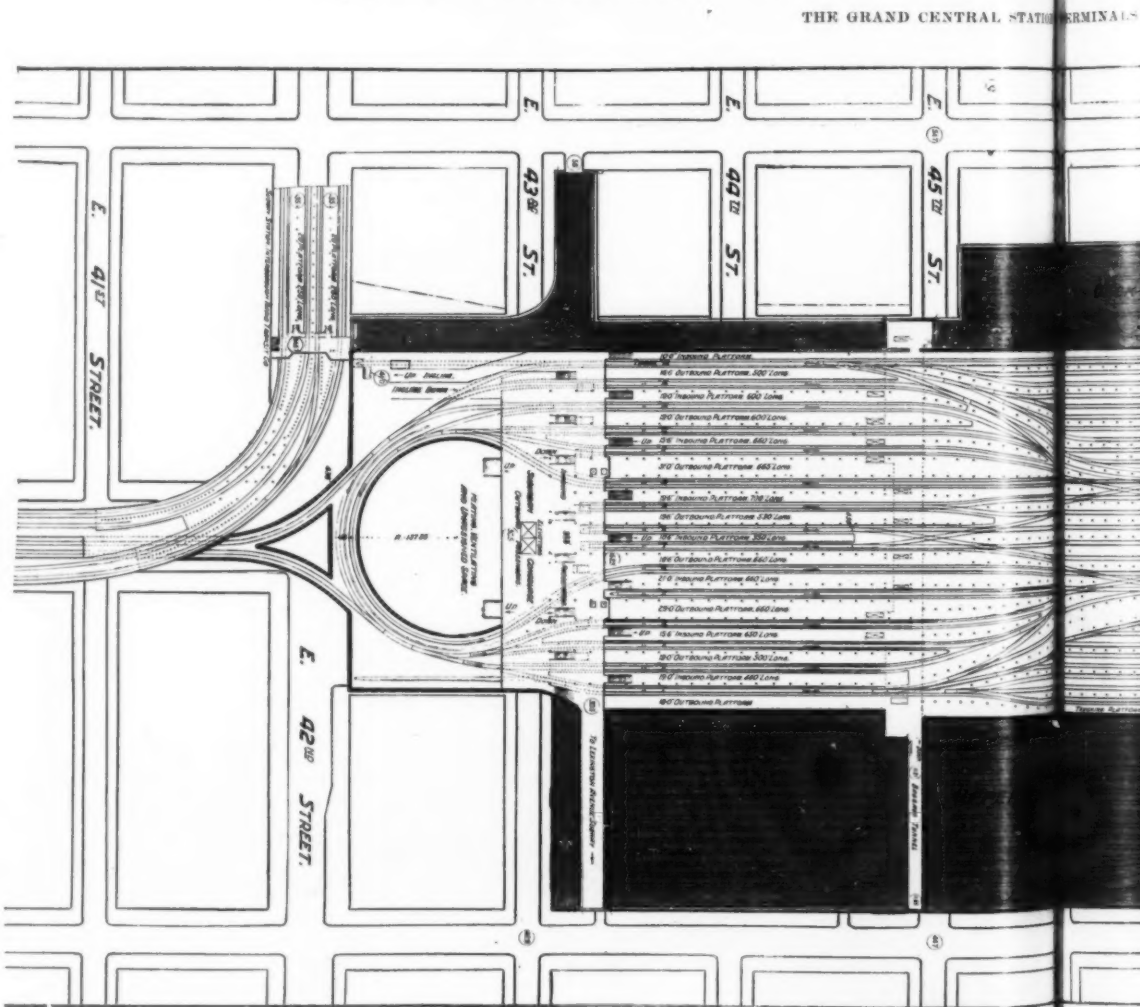
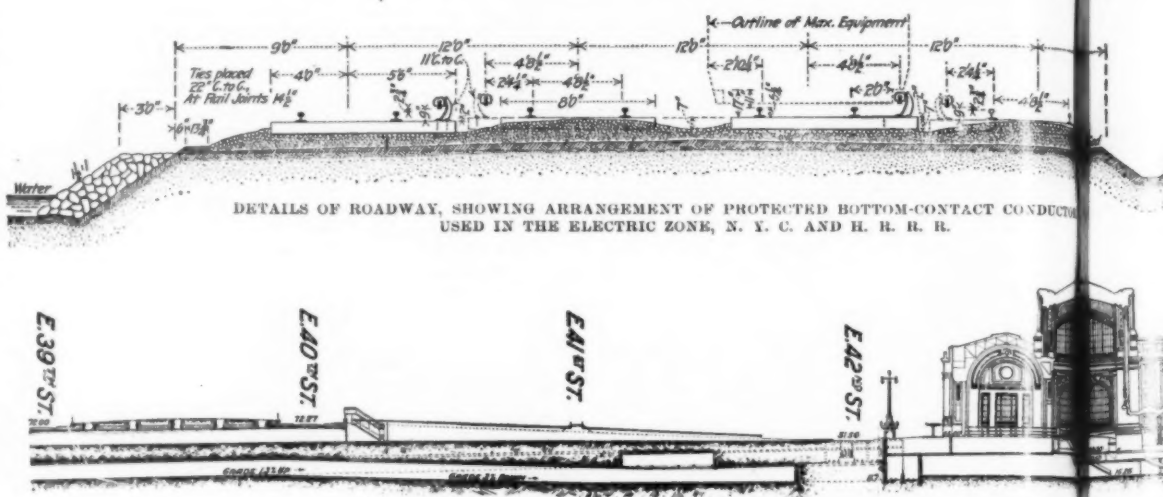
The locomotive is of 2-8-2 type and weighs 95 tons in working order. It carries four motors of novel construction, one on each driving axle, giving a total rated power of 2,200 horse-power, or about 3,000 horse-power maximum. The armatures are mounted directly on the axles, and the field magnets are integral with the locomotive frame. Each motor has two field poles, in the horizontal plane; the pole faces are vertical planes, instead of being concave, as usually. This permits considerable vertical play of the magnets with respect to the armature, which fact is taken advantage of, to decrease the weight carried directly on the axle (without springs), by mounting the magnet frame on springs. The motors have ordinary series winding, and are arranged to be connected either all four in series, or two in parallel and the two sets in series, or all four motors in parallel. The motor circuits are

the main frame by a radius arm, and, as the driving wheel base is only 13 feet, the locomotive is very stable laterally.

the main frame by a radius arm, and, as the driving wheel base is only 13 feet, the locomotive is very stable laterally.

DIMENSIONS OF NEW YORK CENTRAL ELECTRIC LOCOMOTIVE.

General.	
Class of traffic.....	Fast passenger
Gage, standard.....	4 ft. 8 1/2 in.
Total length over buffer platforms....	37 ft.
Extreme width.....	10 ft.
Height of top of cab.....	14 ft. 4 in.
Running Gear.	
Driving wheels, 8, diameter.....	44 in.
Truck wheels, 2 front, 2 rear, diameter.....	36 in.
Trucks.....	Swing center
Diameter of driving axles.....	8 1/2 in.



TRACK DIAGRAM OF THE NEW YORK CENTRAL'S LOWER TERMINAL. THE ELECTRIFICATION OF THE NEW YORK CENTRAL'S TERMINAL LINES.

handled by an individual switch system, with master controller, the regular Sprague-General Electric multiple-unit system. The switches or contactors are arranged along the central corridor of the cab. This system permits two locomotives to double-head, and puts both under full control from one cab.

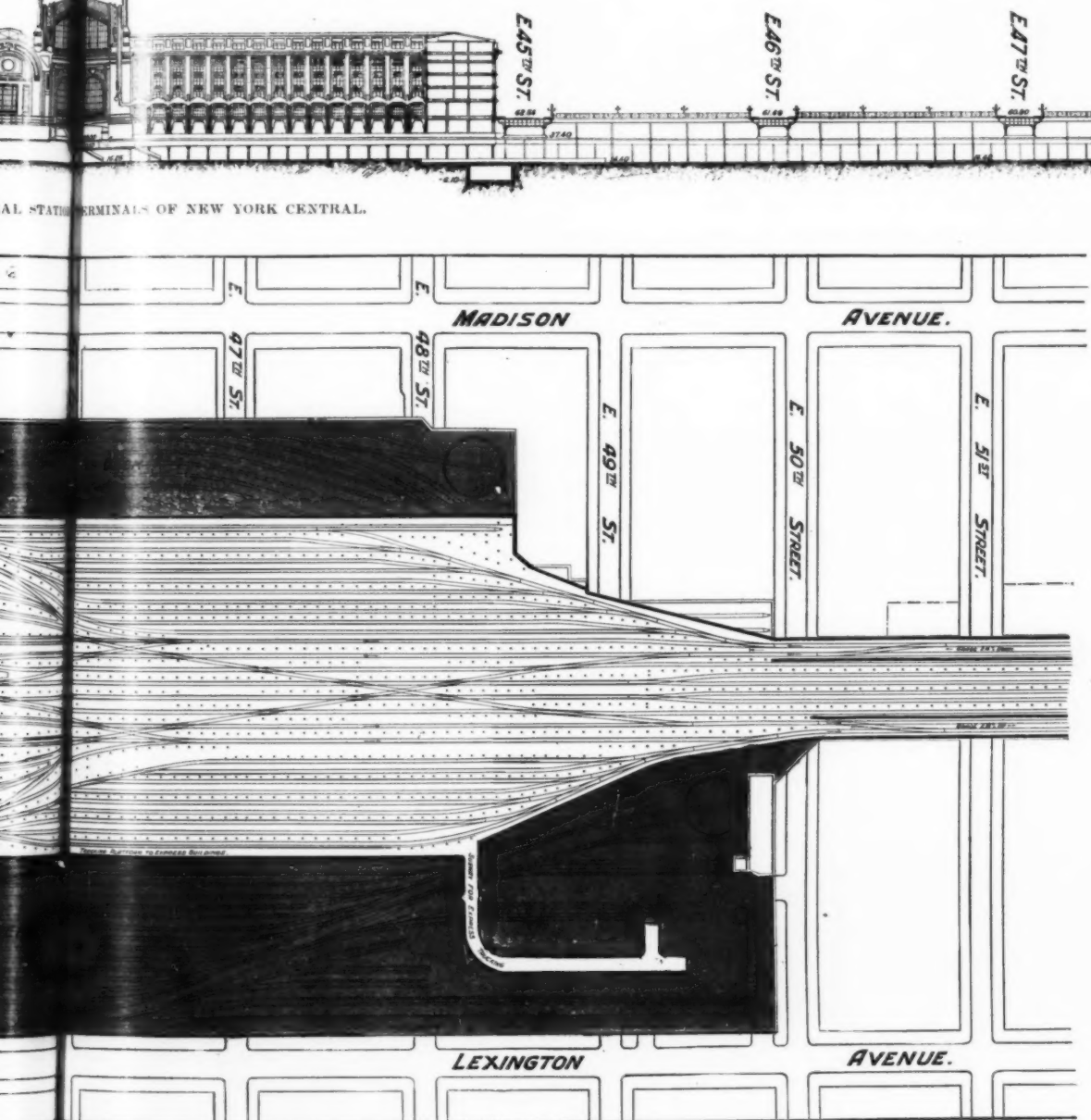
Current is collected by four third-rail shoes on either side, or by two overhead contacts fitted on a linked diamond frame for raising and lowering; both third-rail shoes and overhead contacts are actuated by air. Automatic airbrakes, pneumatic sander, whistle, and bell-ringer are fitted. Air is furnished by a twin compressor driven by two motors, the capacity being 75 cubic feet free air per minute, at a reservoir pressure of 130 pounds per square inch.

The two-wheel truck at either end is connected to

Wheel Base.	
Driving.....	13 ft.
Total.....	27 ft.
Weight.	
On driving wheels.....	138,000 lb.
On truck wheels.....	52,000 lb.
Total, in working order.....	190,000 lb.
Power.	
Supply, direct current.....	600 volts.
Conductors.....	Overhead and third-rail
Motors, four G. E.—84—A. each 550 H.P. rated.....	2,200 H.P.
Maximum power of locomotive.....	3,000 H.P.
Normal full-load current.....	3,050 amp.

The locomotive was designed to enable an acceleration of 0.5 to 1.0 mile per hour per second to be obtained with trains up to 800 tons, and to give a maximum speed of 60 miles per hour with a 500-ton train. In actual test on a four-mile track near Schenectady the results in both speed and acceleration were, it is reported, wholly satisfactory.

The weight of car body, in both motor cars and trailers, is 53,000 pounds, without electrical equipment. The light weight of the motor car is 102,600 pounds.



The frames and bodies of these cars are made of structural-steel and pressed-steel shapes, the window and door casings and frames and the moldings are of pressed steel, and the fittings of metal or fireproof material.

Each motor car has one truck equipped with motors, and one idle truck. The weight per axle, loaded, on the motor truck is 32,390 pounds; on the traller truck of motor cars, 23,300 pounds; on the traller cars the

sure of 185 pounds, and the steam will be superheated to 200 deg. F. over and above the temperature due to steam pressure. The superheaters in each boiler will contain 1,230 square feet of heating surface, and they are made up of 168 two-inch tubes, each 13 feet 5 inches in length. Each section of the power station containing four boilers is equipped with one boiler feed pump of the duplex outside-packed piston type. The pumps are designed for hot water, and each pump has a capacity to supply eight boilers under full load conditions. The feed-water heaters are of the closed type corrugated-tube Wainwright counter-current design.

Each power station is designed to accommodate six 5,000-kilowatt turbo-generators, four of which are being installed for initial operation. The turbines are of the Curtis five-stage vertical type. These machines are about 15 feet in diameter at the base, and 35 feet high from the floor to the top of the generator.

The turbine structure is mounted upon a cast-iron base, forming an exhaust chamber in which is provided the opening to the condenser and to free atmospheric exhaust. The shaft of the turbine is separated from that of the generator above, the connection between

normally rated capacity of the turbines. The intake and discharge circulating tunnels for the condensing system are elliptic in shape, 7 feet 3 3/4 inches x 9 feet 11 inches.

The generators each have a capacity of 5,000 kilowatts, and are wound for three-phase current of 25 cycles and 11,000 volts pressure. The armatures are star-connected, and the neutrals are grounded through individual cast-iron grid resistances connected to a common ground bus, limiting the ground current to an amount sufficient to operate the line overload relays. The leads of the generators are brought down to the floor through brass pipes to the ducts leading to the high-tension switches, the arrangement being such that no high-tension conductors are exposed in the turbine room.

The exciter system at each power station will consist of two 150-kilowatt turbo-generators and one 150-kilowatt induction motor generator furnishing current at 125 volts pressure; also one exciter storage battery

the conductors will be carried in 3 1/2-inch steel pipes supported by brackets.

Across the Harlem River the conductors will be in a submarine cable laid in a dredged trench in the bed of the river, backfilled with gravel.

At points where the lines change from overhead to underground construction, cable towers of attractive architectural design will inclose the connections, together with lightning arresters and disconnecting switches.

SUB-STATIONS.

At the sub-stations the high-tension current is stepped down to direct current at 666 volts for delivery to the third rail. The main equipment of each sub-station consists of three rotary converters and their accompanying transformers and subsidiary apparatus. The arrangements provide for a future installation of five rotary converters. The relative locations and capacity of the sub-stations is shown in the following table:

Sub Station No.	Location.	Area of Main Floor.	Miles from Grand Central Station.	Present Installation of Rot. Con.	Future Installation of Rot. Con.
1.....	Grand Central Terminal.....	4706.6 square feet.	0.38	3 of 1,500 kilowatts	5 of 1,500 kilowatts
2.....	Mott Haven.....	3845.27 " "	5.47 Hudson Division.	3 of 1,500 " "	5 of 1,500 " "
3.....	King's Bridge.....	3845.27 " "	5.49 " "	3 of 1,000 " "	5 of 1,000 " "
4.....	Yonkers.....	2639.23 " "	9.44 " "	3 of 1,000 " "	5 of 1,000 " "
5.....	Irrington.....	3845.27 " "	15.64 " "	3 of 1,000 " "	5 of 1,000 " "
6.....	Ossining.....	3845.26 " "	22.11 " "	3 of 1,000 " "	5 of 1,000 " "
7.....	Bronx Park.....	3845.27 " "	30.31 " "	3 of 1,000 " "	5 of 1,000 " "
8.....	Scarsdale.....	3845.27 " "	39.30 " "	3 of 1,000 " "	5 of 1,000 " "

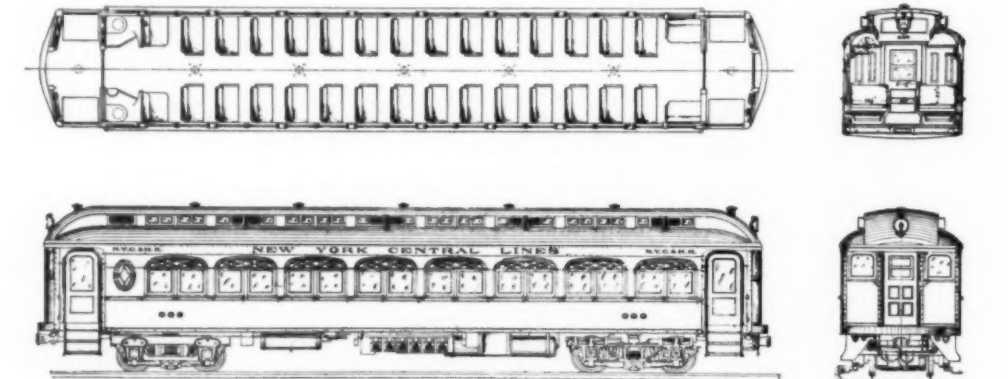
consisting of 74 cells, type R-21, having a capacity of 1,200 amperes for one hour, with spare space in the tanks for increasing the capacity to 1,800 amperes for one hour. Exciter generators and battery are connected to two independent positive buses and one common negative bus. The battery has two end cells on the positive side. One positive bus serves for field excitation of the 5,000-kilowatt generators only, while the other serves for certain lights and motors in the station.

Each sub-station is provided with a battery equipment described below, and provision is made for any extensions that may be expected from increase of traffic.

The following general principles were adopted in the design of the sub-stations: (1) The path of the energy to be as direct and as short as possible from the high-tension transmission lines to the D. C. feeders. (2) The wiring to be as little exposed as possible and yet readily accessible. (3) All machinery to be on the same floor as the operating boards. (4) The principal apparatus to be under the direct control of the operator while standing at the operating boards. (5) All

TRANSMISSION LINES AND SUB-STATIONS.

The current generated at the two main power stations at Port Morris and Yonkers is transmitted as



PLAN, SIDE AND END ELEVATIONS, AND SECTION OF STEEL SUBURBAN MOTOR CAR. THE ELECTRIFICATION OF THE NEW YORK CENTRAL'S TERMINAL LINES.

three-phase, twenty-five cycle, 11,000-volt alternating current to eight sub-stations located as follows: Fifth Street and Lexington Avenue, Grand Central Terminal, New York; Mott Haven, Kingsbridge, Yonkers, Irvington, Ossining, Bronx Park, Scarsdale.

The transmission lines are partly overhead and partly underground. The system is designed to give the greatest protection against interruptions of all kinds. Each sub-station may be fed from either power station, and the lines are so disposed that no ordinary accident could cut off a sub-station from its power supply.

apparatus and machinery to be so arranged that the effects of an accident will be confined to the place where it occurs. (6) The risk of accident to the operator to be as slight as possible. (7) Stations to be fireproof.

Two sub-stations are equipped with single-phase 550-kilowatt transformers to supply the 1,500-kilowatt converters, whereas the sub-stations with 1,000-kilowatt converters have 375-kilowatt transformers. These have a normal ratio of 11,000 to 460 volts, and are provided with extra taps for varying the voltage according to the drop in the transmission lines, or according to the distribution of load among the sub-stations. They are of the air-cooled type with terminals underneath.

The air is supplied by two induction-motor-driven blowers, one of which suffices to supply the station.

Are of the sextuple connection three-phase type, which combines the advantages of the ordinary three-phase and six-phase types. They convert the alternating current at 460 volts into direct current at 666 volts.

LINES.

All overhead transmission lines are supported by lattice steel poles set in concrete foundations. Conductors will be of either 4/0 bare copper wire stranded cable or of aluminium stranded cable, spaced 36 inches apart on the cross arms.

All overhead lines are protected by the latest form of lightning arresters, and details of the overhead construction have been considered so minutely that the success of the system is assured.

Underground cables have three conductors of 4/0 stranded copper with paper insulation and lead sheathing. Duct lines are of vitrified tile covered with waterproofing and laid in concrete. The manholes placed at stated intervals on the lines are designed for arrangement of cables with regard to the best manner of handling and supporting them when they are installed. Each cable lies on shelving of concrete supported on iron pins. These shelves can be removed when necessary, and are designed to facilitate the easy handling of cables as well as protection to sheathing and splicing. Manholes are roomy, and are laid out to permit the bending of cables in easy curves. Much ingenuity has been used in the construction of these underground lines and manholes, and many of the ideas developed are novel.

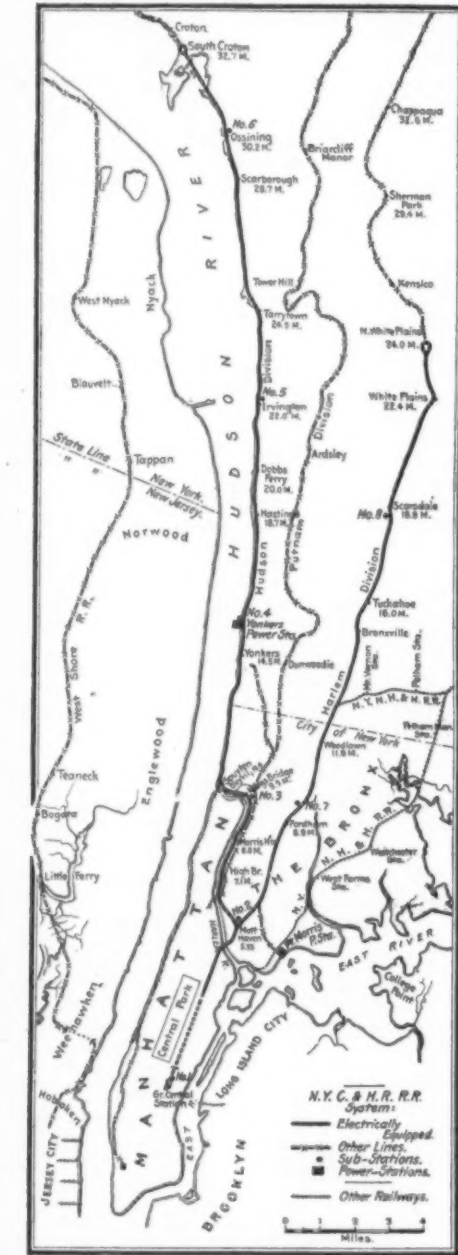
Through the Park Avenue tunnel and along the viaduct, and also through the Harlem Division depression,

The electric storage battery equipment is believed to be the largest railway battery installation in the world. It not only takes care of load fluctuations, but it is sufficiently large to operate the entire system under normal conditions for a period of one hour, in case of failure of generating apparatus. Five of the batteries have an output each of 2,250 amperes for one hour, and the others give 3,000, 3,750, and 4,020 amperes respectively.

The batteries are located in buildings adjoining the sub-stations, and are operated in connection with boosters and switching apparatus in the sub-station.

The discharge is governed by a carbon regulator working in connection with exciters and boosters, the effect of which is to make the batteries discharge when there is heavy demand for current and to charge when the demand is light.

The battery houses are of the most modern construc-



THE ELECTRIC ZONE OF THE N. Y. C. AND H. R. R.

the two being made by a coupling, so that the machine can be readily taken apart.

The shaft is borne by a step bearing consisting of two cast-iron blocks between which water is used for lubrication under a pressure of 300 pounds per square inch, exerting a sufficient force to slightly raise the moving structure.

The condensing apparatus is external to the turbines. The condensers are of the counter-current surface type, and each is directly connected to its turbine base, and contains about 17,000 square feet of cooling surface. They are guaranteed under full load to maintain a vacuum of 28 inches with cooling water at a temperature of 70 deg. F. 30 inches barometer.

As an evidence of the high efficiency expected of the condensing system, it may be stated that the manufacturer has guaranteed that the temperature of condensed steam measured in the condenser hot well will be within 1 deg. F. of that corresponding to the pressure measured in the condenser. All parts of the machinery have been designed to operate smoothly and quietly under all loads up to 50 per cent above the

tion, and have acid-proof floors of vitrified brick. The heating and ventilating systems are of the most approved type, and are well protected against acid fumes.

The converters may be started either from the direct-current or alternating-current side. In the latter case a gradual application of voltage is insured by taking current from several taps in the secondaries of the power transformers. Starting from the direct-current bus, the machine is started as a direct-current motor through a rheostat. When a speed above synchronism is reached, the direct circuits including the shunt field are opened, and the machine runs by its momentum only. The alternating current is then put on by closing the oil switch, and the machine runs as a synchronous motor. It is then only necessary to close the shunt field circuit to put the machine in synchronism. These operations are made to follow each other rapidly, and are effected by the use of a special combination switch.

The direct-current feeder system is designed to give a duplicate path for the current from the sub-station to the third rail. It is also designed so as to confine any trouble which may occur to one track only, thereby making any interruption of traffic as slight as possible. Switches are provided at the third rail to disconnect all feeders at that point in case of a ground between the rail and the station. A train length section of third rail is separately fed from the sub-station, and is designed to prevent trains bridging between sections. All direct-current cables are installed in tile conduits close to the tracks, except the auxiliary feeders, which join the sub-station buses and supplement the conductivity of the third rail. These are, in some localities, run overhead on the transmission poles.

The four third rails and auxiliary feeders are joined together through circuit breakers situated in small houses at intervals along the line, thereby increasing the effective conductivity.

#### THIRD RAIL.

An under-contact third rail will be used. The rail is of special bullhead section, 70 pounds to the yard, with high electrical conductivity. It is supported by cast-iron brackets bolted to long ties spaced 11 feet centers. Insulators fit loosely over the top and web of the rail, thus allowing some vertical play. A clamp fits around the side and top of the insulator and is bolted to the bracket. The top and sides of the third rail will be covered with insulating material, to give thorough protection against accidental contact.

The entire engineering work outlined is under the charge of Mr. W. J. Willgus, vice-president, whose staff is organized in three divisions, concerned with electrification, construction, and architecture respectively. The electrification has been planned in its general features by the Electric Traction Commission, of which Mr. Willgus is chairman, Messrs. J. F. Deems, B. J. Arnold, and Frank J. Sprague are members, and Mr. Edwin B. Katte, the company's electrical engineer, is secretary. The details of the power plants described in this article have been worked out under Mr. Katte's direction. Messrs. Reed & Stem are the architects, the foundation having been designed in the engineering department of the railroad company.

#### RELATION OF WING SURFACE TO WEIGHT.\*

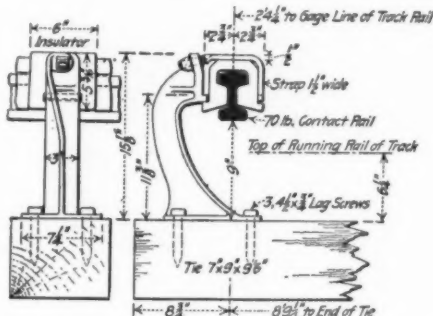
By R. VON LENDENFELD.

SUCCESSIVE investigators, myself among them, have studied the comparative relation between the weight and the dimensions of flying animals, with special reference to the extent of wing surface. Some hundred species of bats, birds, and flying insects have been examined in this way, the results of these researches being given in the following table, in which the animals are arranged according to weight of body.

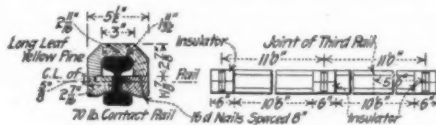
Animal.	Weight.	Wing Surface.	Wing Surface to 1 Gm. Weight.
	Grms.	Sq. Cm.	Sq. Mm.
Albatross ( <i>Diomedea exulans</i> )	12,000	8,000	67
Bustard ( <i>Otis tarda</i> )	9,000	5,937	62
Sea Eagle ( <i>Haliaeetus albicilla</i> )	5,000	7,937	100
Stork ( <i>Ciconia alba</i> )	2,265	4,500	199
Flying Fox ( <i>Pteropus edulis</i> )	1,380	1,630	118
Pheasant ( <i>Phasianus colchicus</i> )	1,000	890	88
Herring gull ( <i>Larus argentatus</i> )	1,035	2,380	230
Crow ( <i>Corvus cornix</i> )	505	1,280	216
Partridge ( <i>Pardipha cinerea</i> )	320	356	115
Dove, pigeon ( <i>Columba livia</i> )	200	608	307
Sparrow hawk ( <i>Falco tinnunculus</i> )	200	680	341
Laughing gull ( <i>Larus ridibundus</i> )	197	662	336
Thrush ( <i>Turdus pilaris</i> )	100	186	186
Swift ( <i>Cypselus apus</i> )	35.5	144	439
Sparrow ( <i>Passer domesticus</i> )	28	70	240
Swallow ( <i>Hirundo rustica</i> )	18	110	611
Titmouse ( <i>Parus major</i> )	14.5	62	427
Small bat ( <i>Vesperugo pipistrellus</i> )	3.7	50	1,351
Sphinx moth ( <i>Sphinx ligustri</i> )	1.92	18.64	971
Flatbellied dragonfly ( <i>Labeolla depressa</i> )	.4	13.5	2,316
Bumblebee ( <i>Bombus pratorum</i> )	.44	1.03	234
Swallowtailed butterfly ( <i>Papilio polydorus</i> )	.34	11.2	3,294
Marden dragonfly ( <i>Chloroceryx virgo</i> )	.2	13.94	6,970
Cabbage butterfly ( <i>Pieris brassicae</i> )	.08	9.28	11,600
Honeybee ( <i>Apis mellifica</i> )	.074	.39	528
House fly ( <i>Musca domestica</i> )	.01	.18	1,800
Gnat ( <i>Culex pipiens</i> )	.003	.3	10,000

It is seen from the foregoing table that the relation of the extent of wing surface to the weight of body is not uniform, as might have been expected, but exceedingly variable. For instance, to 1 gramme of weight the bustard has 62 millimeters<sup>2</sup> of wing surface, while the cabbage butterfly has 11,600. Careful observation shows, however, that in the main the variation of this ratio depends on the size of the animal, or, stated in general terms, the wings are relatively

larger the smaller and lighter the animal to which they belong. It is shown also that the variations from the general rule depend on the fact that the mode of flight is different in different animals. Some flying creatures overcome weight by the rapid movement of their wings; others, especially at the beginning of a stroke, take advantage of the internal atmospheric currents, and use the enormous resistance of the air for their purpose. The first class, to which the sparrow and the honeybee belong, may be designated as flapping flyers, and the last class, of which the albatross and the sea eagles are examples, as sailing flyers. These extreme types of the so-called flapping and sailing flyers are connected by an unbroken chain of flying creatures,



DETAILS OF PEDESTAL AND INSULATOR.



DETAILS OF PROTECTION SHEATHING.

Third Rail Conductor N. Y. C. & H. R. R. R.

not all of which are so exclusively either flappers or sailers as the birds just named.

As might be expected, the flapping flyers have comparatively small wings, which move swiftly by the aid of powerful muscles, while the wings of the sailers are moved by weaker muscles and more slowly. If we take these two classes into consideration separately, as in the following tables, it is clearly shown that the wing surface increases with decreasing weight of body.

Animal.	FLAPPERS.		Wing surface to 1 gramme	
	Weight.	Grms.	Weight.	Mm <sup>2</sup>
Bustard	9,600	62		
Pheasant	1,000	82		
Partridge	320	105		
Sparrow	28	200		
Bumblebee	0.44	234		
Honeybee	0.074	528		
House fly	0.01	1,800		
Gnat	0.003	10,000		

Animal.	SAILERS.		Wing-surface to 1 gramme	
	Weight.	Grms.	Weight.	Mm <sup>2</sup>
Albatross	12,000	67		
Sea eagle	5,000	160		
Stork	2,265	199		
Silver gull	1,035	230		
Sparrow hawk	260	261		
Laughing gull	197	336		
Virgin dragon fly	0.2	6,970		
Lemon butterfly	0.183	28,710		

Of this fact there can be no doubt, and the question arises why this is so. Müllenhoff and others who have

comparing animals of the same mode of flight. Thus

the formula  $\frac{\sqrt{\text{wing surface}}}{\sqrt{\text{weight}}}$  gives in the partridge 4.03,

in the sparrow 2.86, and in the bumblebee 1.33.

If, however, such a constancy existed, which we see is not the case, the paradox that lies in the relative increase of wing surface with decreasing weight of body would by no means be set aside; but in similarly formed flying creatures it is not so essential that they shall be morphologically alike as that all shall perform the task of overcoming weight equally well, and thus be functionally the same.

Thus it becomes a question of power to press down upon the air, and this power depends not only on their size, but upon the swiftness of their movement against the air and its resistance. Hence, the flapping flyers, whose wings move in a small angle, have greater lifting power the longer their wings and the more strokes they make in a second.

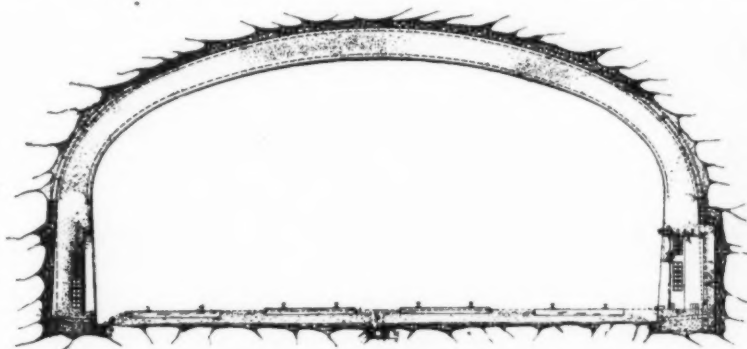
A sparrow has a wing length of about 10 centimeters and makes about 12 wing strokes in a second; a bee with a wing length of approximately 6.3 millimeters makes, as Marey has shown, about 190 strokes in a second, 6.3 times 190 about equaling 100 times 12. The slow wing movement used by the sailing birds when needed shows the same. The stork has a wing length of 68 centimeters and makes 1 1/4 strokes in a second, and the laughing gull with a wing length of 39 centimeters makes 3 1/2 strokes in the same time. In these instances also the results are not dissimilar. In general, one may therefore say that the movement of the wings against the air in many birds of the same mode of flight is of equal rapidity, this being true of the flapping flyers as well as the sailers. Although the smaller flyers have relatively larger wings than the greater, one can not for this reason assert that the movement of the wing surface against the air would be slower.

In view of the biological principle that organs are not greater than demanded by their function, we must conclude from the known facts that the smaller animals need relatively larger wings to accomplish what the larger and heavier attain with their relatively smaller ones. The fact that a wing surface of 67 millimeters<sup>2</sup> per gramme enables the albatross to sail, while the laughing gull requires 336 millimeters<sup>2</sup> for the same purpose, and that the bustard gets along with 62, while the sparrow needs 200 and the fly 1,800 millimeters<sup>2</sup>, can be explained only on the supposition that the resistance of the air against moving wings is not directly proportional to their size, but that in enlarging the wings the resisting power of the air against them increases in a greater ratio than their superficial dimensions. Knowing that the air requires an appreciable time to yield to the pressure of the moving wing, and that the larger the wing surface the greater the quantity of air displaced and the greater the resistance of this compressed air to the subsequent wing strokes which must act upon it, it is evident that this conclusion is correct.

There can therefore be no doubt that increasing size of body is accompanied by a relative decrease of wing surface, and from this fact we are able to draw interesting conclusions as to the size of the wings a man would need to be able to fly. If we show the relation of the weight to the size of the wing by the means of co-ordinates, connecting the points thus gained by a curve, and then extend this curve as demanded by the relative weight of the heaviest animal, we secure an approximate illustration of the wing size which such bodies would require. Since the muscular power of a human being would by no means suffice for flapping flight, it could only be a question of sailing flight in this case. I have therefore drawn a curve for sailing flyers on the principle above indicated, from which the following is deduced:

70 kilogrammes, weight of body, would require 32 millimeters<sup>2</sup> of wing surface per gramme.

80 kilogrammes, weight of body, would require 31 millimeters<sup>2</sup> of wing surface per gramme.



SECTION THROUGH SPLICING CHAMBER.

#### THE ELECTRIFICATION OF THE NEW YORK CENTRAL'S TERMINAL LINES.

Interested themselves in this inquiry have answered it from the morphological point of view. From the entirely correct principle deduced from the position of these investigators, that with increasing size the linear dimensions increase in the first, the magnitude in the second, and the weight in the third ratio, they conclude that the wing surface is not to be compared directly with the weight, but the square root of this surface with the cube root of the weight. In fact, however, the figures thus obtained show no constancy, even when

90 kilogrammes, weight of body, would require 30 millimeters<sup>2</sup> of wing surface per gramme.

100 kilogrammes, weight of body, would require 29.5 millimeters<sup>2</sup> of wing surface per gramme.

According to the foregoing, if the combined weight of the body and the mechanical flying apparatus amounts to 90 kilogrammes, in order to sail like an albatross a man would require 90,000 times 30, or 2,700,000 millimeters<sup>2</sup> of wing surface; that is to say, two wings furnishing together 2.7 square meters of surface.

\* Translated from Naturwissenschaftliche Wochenschrift and published in Annual Report of Smithsonian Institution.

### THE CONSTRUCTION OF A REINFORCED CONCRETE POWER HOUSE.

The number of concrete structures is constantly increasing. An excellent example of an industrial building in which are embodied many of the new concrete ideas is furnished by the power house just completed for the Baltimore Electric Power Company.

This power plant, which is 70 feet high and covers an approximate area of 72 by 180 feet, is considered absolutely fireproof. The engine room is on the ground floor, where have been installed eight Sterling boilers



Fig. 1.—This is a piece of electrically-welded fabric so cut as to expose the weld between the longitudinal and the transverse wires. It is not possible to detect the point of junction between the two wires; in other words, there is a perfect weld.

with superheaters, which supply steam to Westinghouse-Parsons turbines in direct connection with Westinghouse generators. The boilers are fed by mechanical stokers, which are in turn supplied with coal through chutes from the coal pockets.

cause with the long lengths in which it comes they were able to make the reinforcing continuous for the whole width of the building—an important feature in adding strength to the structure—and second, because the cross wires not only serve to hold the main reinforcing members in their exact positions, but they take up whatever strain may be exerted in the opposite direction. The feature of having a reinforcing material which

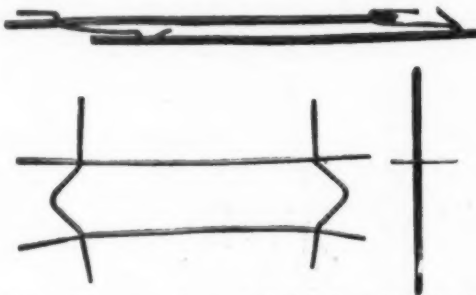


Fig. 2.—These are pieces of electrically-welded fabric which have been twisted and distorted out of shape without in any way impairing the solidity of the weld. There is also shown at the right a piece which has been tested almost to the breaking point. The wire has yielded at a point other than at the weld.

the workmen cannot misplace is one of the strongest points of this system of reinforcement, because it obviates the necessity of using many high-priced inspec-

feet. A wire of a heavier gage may be laid in lengths up to 60 feet, which may be locked or hooked to form a continuous bond. As contrasted with the method of lapping the ends of steel fabric every few feet, the continuous-bond system makes the entire collapse of an arch impossible unless the weight imposed on the arch is sufficient to break all wires. In the construction of roofs of great length, this steel fabric may be used to special advantage. The accompanying illustration shows the construction of a roof on one of the harbor docks of Montreal. The wire fabric is first laid, and then raised slightly from the surface by means of wooden blocks. The concrete is then poured over it in sufficient quantities to imbed the fabric, thus forming a continuously welded structure.

All reinforcing is made on direct lines of tension, as both theoretical and practical demonstrations have proven the weakness of indirect lines.

Reinforcements may be carried the entire length of a building several hundred feet long, without a break, when secured at the front or rear, and, owing to the continuous bond, the reinforcing is equally strong at all points, as the members are spaced exactly two to four inches apart. The result is an actual monolithic slab.

That the fabric is strong at the weld is shown by the accompanying illustrations, Fig. 1 of which shows a section of wire at the weld, and Fig. 2 of which shows pieces of the fabric distorted without impairing its solidity. Further tests have shown that this fabric, when subjected to tension until broken, yields at a point other than the weld. The wire shown at the right of Fig. 2 has been tested almost to the breaking point, which may be seen at the depression above the weld.

The two main methods of reinforced concrete floor

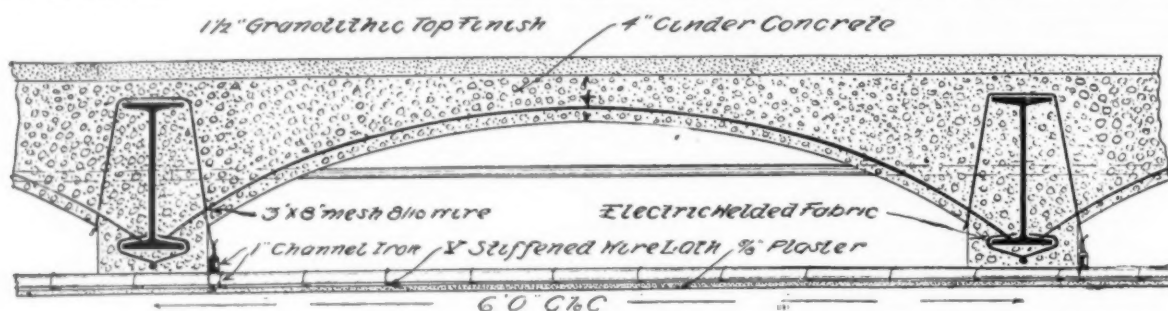


Fig. 3.—CROSS-SECTION OF CONCRETE FLOOR WITH ELECTRICALLY-WELDED FABRIC REINFORCING, SHOWING THE METHOD OF SUSPENDING THE CEILING.

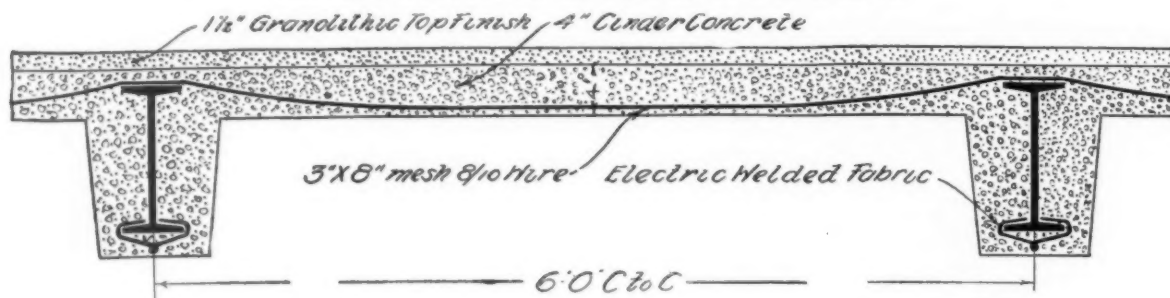


Fig. 4.—CROSS SECTION OF REINFORCED CONCRETE FLOOR, SHOWING THE GRANOLITHIC TOP FINISH METHOD OF FIREPROOFING SOFFITS OF BEAMS.

The upper third of the building contains these coal pockets, which are filled by means of an industrial railway, which runs into the building from an adjacent coal-handling plant. In supporting the great pressure to which these floors are subjected, a continuous reinforcing bond has been used in the concrete.

tors to watch every detail of the work, and guards against the mistakes which may be made by the misplacing of ordinary reinforcement.

The superiority of this form of stone or cinder concrete work, reinforced with embedded steel wire, over the system of fireproof arch, built up of particles in the

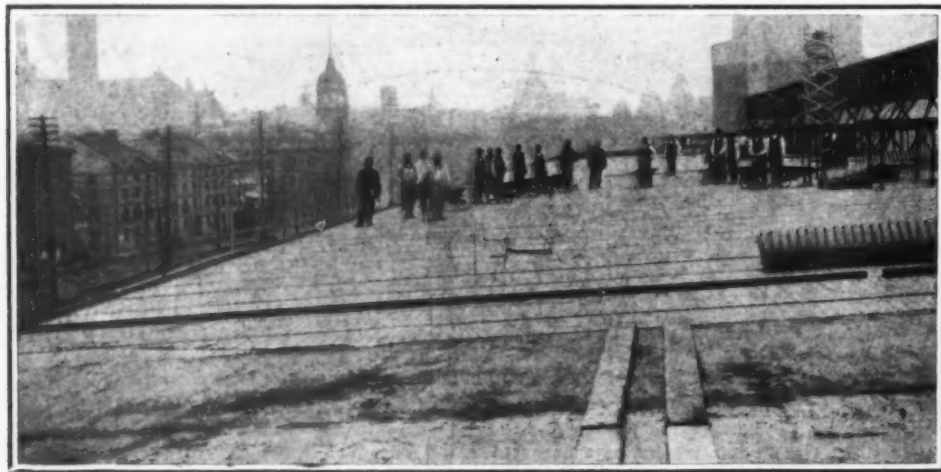
construction are shown by the accompanying diagrams. In Fig. 3 two I beams are shown, at the bases of which are attached, to extend the entire length of the beam, electrically-welded fabric. To this is attached the welded fabric, which is laid over wood centers about an inch from the under side of the arch, and the ends placed on the tops of the lower flange I beams. The crown of the arch consists of about 4-inch cinder concrete, which may be covered with a top finish, and to the bottom of which may be suspended the ceiling.

The second method of floor construction is shown in Fig. 4, which is self-explanatory. This type is designed for use in factories and public buildings. The value of the fabric in supporting the concrete at the bases of the beams is apparent from the fact that the failure of concrete in fireproof construction occurs at the points so exposed.

Electrically-welded fabric is also being used with marked success in the construction of concrete shafts, sewers, and similar work. For such purposes the fabric is used in sufficient lengths entirely to cover the circumference of the work being done—a method claimed to be safer and cheaper than that involving the use of single rods. In this work a 3-inch hook is provided on each meeting wire, by which the ends are secured.

An example of the use of electrically-welded fabric is furnished by the conduits just completed for the Baltimore Electric Power Company. These conduits are about 600 feet long and 5 feet diameter. The entire circumference is reinforced by a continuous bond of wire fabric, a sectional view of which is shown in the accompanying illustration, Fig. 5. These conduits are buried under 30 feet of clay, and the reinforcement is so placed as to resist this pressure on the under side of the 4-inch crown.

The reinforcement spreads away from the exact circumference on the bottom of the conduit in such a way that the bottom is imbedded in the concrete to a depth of 12 inches. The concrete is thus laid in order to resist the upward pressure of the water, as the conduit



CONCRETE ROOF ON HARBOR DOCK OF MONTREAL, SHOWING METHOD OF LAYING CONCRETE REINFORCED WITH ELECTRICALLY-WELDED FABRIC.

The manner in which the concrete is reinforced in this building has many features of interest. Instead of using the ordinary steel rods for the reinforcement of the floor slabs between the I beams, the engineers selected Clinton electrically-welded fabric, first, be-

form of hollow clay blocks, is particularly marked for its power to sustain a greater load, either concentrated or distributed. This fabric, which forms the basis of this construction work, is made of drawn wire of from 6 to 10 gage, which may be laid in lengths up to 300

is several feet below the level of the bay. This application of the Clinton fabric is similar to that in the construction of concrete piles, which to an increasing extent are supplanting the wooden piles.

#### THE RISE OF DYNAMICS IN PHYSICS.

In pure dynamics the nineteenth century inherited from the eighteenth that unrivaled feat of reasoning

and force flux, and Stokes (1854) his equally important relation of the line and the surface integral. Legendre (published 1785) and Laplace (1782) were the first to apply spherical harmonics in expansions. The detailed development of volume surface and line potential has enlisted many of the ablest writers, among whom Chasles (1837, 1839, 1842), Helmholtz (1853), C. Neumann (1877, 1880), Lejeune-Dirichlet (1876), Murphy (1833) and others are prominent.

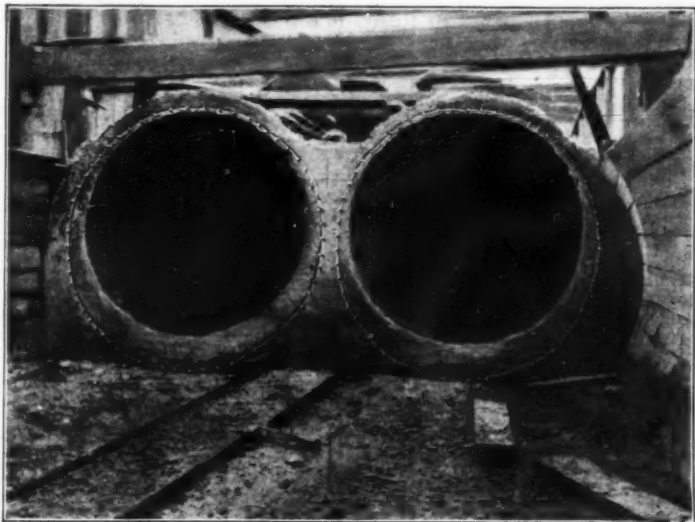


FIG. 5.—SECTIONAL VIEW OF CONCRETE CONDUITS REINFORCED BY ELECTRICALLY-WELDED FABRIC.

called by Lagrange the "Mécanique Analytique" (1788), and the great master was present as far as 1813 to point out its resources and to watch over the legitimacy of its applications. Throughout the whole century each new advance has but vindicated the pre-eminent power and safety of its methods. It triumphed with Maxwell (1864), when he deduced the concealed kinematics of the electromagnetic field, and with Gibbs (1876-78), when he adapted it to the equilibrium of chemical systems. It will triumph again in the electromagnetic dynamics of the future.

Naturally there were reactions against the tyranny of the method of "Histoires." The most outspoken of these, propounded under the protection of Laplace himself, was the celebrated "mécanique physique" of Poisson (1828), an accentuation of Boscovich's (1758) dynamics, which permeates the work of Navier, Cauchy, de St. Venant, Boussinesq, even Fresnel, Ampère and a host of others. Cauchy in particular spent much time to reconcile the molecular method with the Lagrangean abstractions. But Poisson's method, though sustained by such splendid genius, has, nevertheless, on more than one occasion—in capillarity, in elastics—shown itself to be untrustworthy. It was rudely shaken when, with the rise of modern electricity, the influence of the medium was more and more pushed to the front.

Another complete reconstruction of dynamics is due to Thomson and Tait (1867), in their endeavor to gain clearness and uniformity of design, by referring the whole subject logically back to Newton. This great work is the first to make systematic use of the doctrine of the conservation of energy.

Finally, Hertz (1894), imbued with the general trend of contemporaneous thought, made a powerful effort to exclude force and potential energy from dynamics altogether—postulating a universe of concealed motions such as Helmholtz (1884) had treated in his theory of cyclic systems, and Kelvin had conceived in his adynamic gyrostatic ether (1890). In fact the introduction of concealed systems and of ordered molecular motions by Helmholtz and Boltzmann has proved most potent in justifying the Lagrangean dynamics in its application to the actual motions of nature.

The specific contributions of the first rank which dynamics owes to the last century, engrossed as it was with the applications of the subject, or with its mathematical difficulties, are not numerous. In chronological order we recall naturally the statics (1804) and the rotational dynamics (1834) of Poinsot, all in their geometrical character so surprisingly distinct from the contemporary dynamics of Lagrange and Laplace. We further recall Gauss's principle of least constraint (1829), but little used, though often in its applications superior to the method of displacement; Hamilton's principle of varying action (1834) and his characteristic function (1834, 1835), the former obtainable by an easy transition from D'Alembert's principle and by contrast with Gauss's principle, of such exceptional utility in the development of modern physics; finally the development of the Leibnitzian doctrine of work and *vis viva* into the law of the conservation of energy, which more than any other principle has consciously pervaded the progress of the nineteenth century. Clausius's theorem of the "Virial" (1870) and Jacobi's (1866) contributions should be added among others.

The potential, though contained explicitly in the writings of Lagrange (1777), may well be claimed by the last century. The differential equation underlying the doctrine had already been given by Laplace in 1782, but it was subsequently to be completed by Poisson (1827). Gauss (1813, 1839) contributed his invaluable theorems relative to the surface integrals

The gradual growth of the doctrine of the potential would have been accelerated, had not science to its own loss overlooked the famous essay of Green (1828) in which many of the important theorems were anticipated, and of which Green's theorem and Green's function are to-day familiar reminders.

Recent dynamists incline to the uses of the methods of modern geometry and to the vector calculus with continually increasing favor. Noteworthy progress was first made in this direction by Moebius (1837-43, "Statik," 1838), but the power of these methods to be fully appreciated required the invention of the "Ausdehnungslehre," by Grassmann (1844), and of "quaternions," by Hamilton (1853).

Finally the profound investigations of Sir Robert Ball (1871, etc., "Treatise") on the theory of screws with its immediate dynamical applications, though as yet but little cultivated except by the author, must be reckoned among the promising heritages of the twentieth century.

On the experimental side it is possible to refer only to researches of a strikingly original character like Foucault's pendulum (1851) and Fizeau's gyrostat; or like Boys's (1887, etc.) remarkable quartz-fiber torsion-balance, by which the Newtonian constant of gravitation and the mean density of the earth original-

#### THE WILDER RADIAL SNOW-PLOW.

The steam roads have spent years of experimenting at a cost of thousands of dollars, and many lives, to find out what is the best type of snow-plow for general use. The result of their experiments is that the square or shovel-nose plow, consisting of an incline built straight across the track from but a few inches above the rail in front, and extending far back, at an angle of about 30 degrees, above and to the rear of supporting wheels, and a moldboard, either divided in the middle or extending entirely across the incline, and located some distance back from its front edge, has been adopted as the only plow that will stay on the track, and remove the snow, under all conditions, as hard-packed and frozen snow, side-hill drifts, drifts on curves and drifts diagonally across the track, etc.

To adapt this type of plow to electric railways having many curves of short radius and frequent sudden changes of grade has been a difficult problem, but has been successfully accomplished in the Wilder radial snow-plow.

The feature of the plow, and on which Mr. W. E. Wilder was granted a patent, is that the plows are built upon and form a part of the truck, and substantially cover the ends of the body, which terminates particularly at its point of support on the trucks, thereby allowing the plows to turn with the trucks and clear the rails, even on curves of 25 feet radius.

Other features are shown in the accompanying photograph. Some of the general dimensions are: Gage standard, 4 feet 8½ inches; extreme length, 37 feet 9 inches; extreme height, 11 feet 8 inches; width, 8 feet; width, wings extended, 12 feet; wheel base of trucks, 6 feet 6 inches; centers of trucks, 20 feet; wheels, 33 inches, ¾ inch flange, 2½ inches tread; axles, 4½ inches; journals, 3¼ x 6¼ inches M. C. B. type.

Weight (without equipment or ballast), 36,000 pounds. Wings, scrapers, sanders, brakes, etc., operated by air.

Each end of the plow is supplied with a "Huff" two-way locomotive air sander; also a 3-inch chime whistle, and a 12-inch gong is located under each hood.

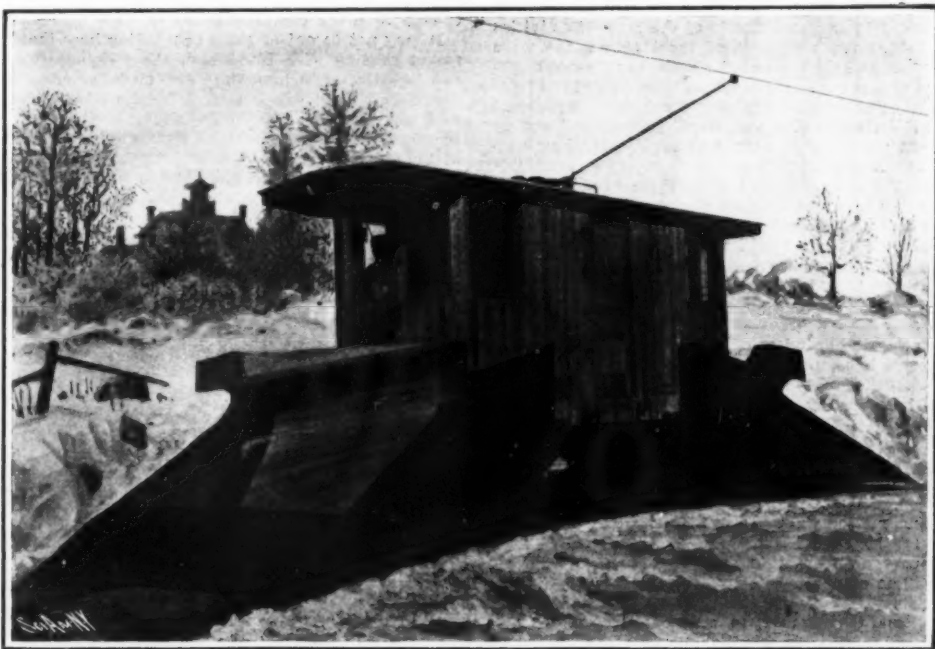
The plow has been used two winters on the Worcester Consolidated Street Railway, and one winter on the Boston & Worcester Street Railway. The equipment used on the Worcester Consolidated was four G. E. 67 motors, with K-6 controllers; and on the Boston & Worcester, four G. E. 57 motors with K-14 controllers; it, however, is designed to take motors as heavy as 125 horse-power.

On the Worcester Consolidated the plow averaged twice the mileage per hour over all other plows, many having heavier equipment, it keeping its lines open when many others were tied up, and was sent repeatedly to open blocked lines, and release stalled and derailed cars and plows.

With its light equipment, it maintained a speed of over 8 miles per hour for miles, through snow that averaged from one to three feet in depth, frequently taking side-hill drifts 3 feet to 5 feet on the high side. At a speed from 15 to 20 miles per hour, the snow would be thrown from 20 to 30 feet from the track and over fences and stone walls.

In fighting snow it has worked continuously for 24 hours at a stretch, yet never was stalled, derailed, or disabled, which could not be said of its competitors.

Two men are all that are needed to operate the plow, though eight have ridden in it without discomfort.



THE WILDER RADIAL SNOW-PLOW.

ly determined by Maskelyne (1775-78) and by Cavendish (1798) were evaluated with a precision probably superior to that of the other recent measurements, the pendulum work of Airy (1856) and Wilsing (1885-87), or the balance methods of Jolly (1881), König and Richarz (1884). Extensive transcontinental gravitational surveys like that of Mendenhall (1895) have but begun.

The body is sheathed inside and out, and the windows have double lights, preventing frost from forming on them, and making the plow warm and comfortable.

This type of plow is said to show an efficiency of at least twenty-five per cent. under general conditions, over all other types of electric plows made at the present time.

## THE HEAD-HUNTERS OF NORTH BORNEO.\*

By A. CAVENDISH.

It is not necessary, for the purposes of this article, to enter into any long preliminary dissertation on the status of North Borneo from a political, economic, or other standpoint. Let it suffice to mention that the territory is a British Protectorate under the administration of one of the few remaining chartered companies. For the rest, let us accept that distant tropical island as the "man in the street" is willing to accept it—merely as "Borneo, where the head-hunters come from."

Moreover, it is not to be supposed that head-hunters are the sole inhabitants of the country. A new arrival who landed a few years ago at the principal port, armed to the teeth with two loaded revolvers and a large bowie-knife, and ready to fight for his head at any moment, was disarmed by a courteous customs official, and directed to a comfortable hotel, from the veranda of which he was able to see English ladies amusing themselves at lawn-tennis, and European children taking their afternoon airing under the charge of their Chinese nurses. It probably would not have occurred to the greenhorn's peace of mind had he known that the dapper little Dyak policeman doing street duty in the road below, with no more deadly weapon than a truncheon, cherished lovingly in his box at the barracks a long, keen knife, whose handle bore a little row of notches. It was merely a valued relic of the policeman's younger days before he left his far-away jungle village to enlist in the white man's service; but each notch could have told its tale of the swift and deadly blow that added yet one more to the number of jungle tragedies and one more to the grim line of trophies hanging in the village long-house.

Head-hunting, as a tribal custom, is rapidly dying out as the "sphere of influence" of the government slowly but steadily extends farther and farther into the interior. As each tribe comes into contact with the British political officers, picked men who have spent years dwelling alone in distant jungle stations, often carrying their lives in their hands, sometimes even sacrificing them, but always watching and studying the wild folk among whom their lot is cast, village by village, chief by chief, "come in" and acknowledge the sway of the white man's rule.

The principal reasons for which heads are taken may be summed up into a few words: first, as a sign of valor and token of manhood; and, secondly, as a ready method of keeping the score in a blood-feud. Some of my readers may be surprised that I stop short at two reasons, for it is a common belief in England that the wild Dyak of Borneo is in the habit of prowling around with a large knife like the lion of Scripture, "seeking whom he may devour," and also that he collects heads in much the same way as his white brother collects postage-stamps or butterflies. This, however, is far from being the case, and the native of the far interior is in reality a very mild savage, whose principal vice is the habit of becoming extremely intoxicated on a fermented drink which he makes from a far too large portion of his rice-crop.

We briefly analyze the first of the two reasons given above for which the young "buck" sallies forth on a head-hunt. Undoubtedly in days gone by the possession of a head implied that the owner—or rather the new owner—had successfully met and conquered an enemy. The young brave swaggered home with his newly acquired trophy, feeling that he had at last donned the *toga virilis* and was entitled to marry a wife and join in the councils of the men. Festivities were held, large quantities of *tapai* (rice-wine) were consumed, and the hero of the hour, having taken possession of a room in the "married" portion of the long-house that shelters the whole of a Dyak village, and found a damsel to share it, would proceed to hang up his head as proudly as his English brother hangs up his first sporting trophy.

Times have deteriorated since these good old days, and to find the reason *il faut chercher la femme*. The young matron whose husband had three heads hanging before his room would sneer at the woman whose spouse could boast but two, and the latter was probably nagged at and badgered (for women are alike the world over) till he went out and procured another. And so by slow degrees the first question asked by a prospective father-in-law of a suitor for his daughter's hand came to be, not "How much brassware have you?" but "How many heads have you?" and no self-respecting girl would look at a man who could not boast his two or three. Well knowing this, the ardent lover would take good care to provide himself with the necessary number. As time went on, successive generations became less particular as to the way the heads were procured, till at the present day a head is merely a head, no matter what the age or sex of the original owner! *Verb. sup.*

To pass on from this somewhat gruesome theme. Were some of our political officers in Borneo to write the histories of all the blood-feuds with which they have dealt, they would fill many and large volumes, for never a tribe but has its two or three. Some of these are of fairly modern origin, and their story, as told over the camp-fire at night by the "old man" of the tribe, takes but a few minutes to relate, every head lost or gained being carefully ticked off on the fingers, the teller being conscious of a score of younger men squatting round, each of whom would consider the omission of his share in the matter as a personal insult. Others again are of such long standing that their origin is lost in the mists of time, and no man of Telo-

cusan can tell why his village is at feud with the people of Panawan.

Various causes contribute to give rise to these blood-feuds. Perhaps during a cattle-raiding expedition by the young bloods of village A, a man of village B will be killed and his head taken to adorn the long-house at A. The villagers of B, biding their time (for these are jungle-folk, and not courageous), will take a party of A people at a disadvantage, and the roof-beam of the long-house of B has a heavier weight to carry. Then a blood-feud is declared, and it becomes the bounden duty of every B man (note the italics) to collect the head of every A person that he can manage to fall upon without much risk to himself; and *vice versa*. Each village keeps count of its score by the simple expedient of hanging up the tangible evidence of every point in the ghastly contest so as to be constantly before its eyes.

And so the game goes on from year to year, and the row of skulls in each village grows longer and longer till there comes a day when the political officer, having felt his way for months, quietly suggests to the chief of A that it might be an advantage to settle matters and make friends with B. The chief laughs at the idea; but all the same it sinks in, and the old man finds himself thinking how good it would be to be able to trade and search for gutta and rotan in the rich country round his rival's village. No more is said; but the white man finds himself shortly in village B, and the process is repeated. The next step is a meeting between the two tribes, a step only gained by almost superhuman patience and tireless diplomacy on the part of the political officer. First A will turn up in full force; but the omens are bad for B, and the meeting falls through. Next time it is B who comes up to the scratch, and A finds an objection. Finally, after lengthy negotiations they meet, both sides fully armed and equally suspicious, and the white man, sitting cool and collected, opens the palaver.

First the score is counted up on both sides, and his heart sinks as he hears that there is a difference of opinion. A claims that B owes three heads; B admits only two. Voices are raised, and the "political" anxiously watches the shades of expression playing like ripples on water over the faces of the men. He detects little signs of feeling invisible to the eye of the inexperienced onlooker, and keeps the peace with a joke here, a proverb there, and rarely, very rarely, with a few words of stern rebuke. At last the score is settled: B owes A two heads, and A will be content to square matters with two slaves. It is explained gently that the government (in Malay *parentah*, an expressive word) will not countenance the barter of slaves, and the suggestion that the value of the heads should be paid over in buffaloes, gongs, or cloth is received somewhat dubiously by both sides. Now the weakness of the Oriental for a bargain asserts itself, and more heated argument ensues; finally the price is settled, and all that remains is to formally seal the contract. A buffalo is killed, a stone planted by each tribe, and the blood of the beast is poured over the stones, fearsome oaths being sworn the while. The ceremony over, the beast is cooked, *tapai* is produced, and the tired "political," leaving the newly made friends to make merry together, goes off to his hut conscious of a day's work done, and with the prospect of a good dinner before him; for was not his orderly very prominent at the killing, hovering round to get a tender joint for his master, and incidentally for himself? And good buffalo-meat is not to be despised in the jungle, as a rare change from the everlasting native fowl.

It may not be out of place to mention here that at a recent settling of a blood-feud, the compensation for two heads, paid in brassware and cloth, amounted, according to the valuation of a coast native who was present, to the sum of thirty dollars, or three pounds. In other words the value of a human life in that part of Borneo was estimated at exactly thirty shillings!

Thus are feuds settled and the day is not far distant when head-hunting in Borneo will be a thing of the past. Even now, under the civilizing influence of one white man in their midst, tribes are burying their heads who in recent years hailed with a week's festivities each addition to their collection; and the "political" notes with quiet pride that the roof-beams of houses long accustomed to bear their ghastly fruit are bared, anyhow temporarily, at his coming.

An incident, amusing, although with its serious side, occurred recently when one of these political officers, into whose life-work we have been taking a glimpse, was down at the coast on a short holiday. He was relating at the dinner-table the story of two prisoners who had escaped from the primitive lockup of his jungle station. They were two Chinese coolies who had absconded from a neighboring tobacco-estate, and the "political" had lost sight of them. "But," said he, "I have sent out my Dyaks (police) and offered a reward of five dollars a head for the two." Now it happened that there was at the table a globe-trotter, saying little, but keeping his ears open, and gathering material for his book on Borneo, the said book to be written, apparently, from his experience of the country as seen from the deck of a coasting-steamer; but this is beside the point. A fortnight later a newspaper in one of the great cities of the East contained a long article, the writer of which waxed eloquent and righteously indignant at the brutal callousness of the British officer who let loose his savage head-hunters to track to a cruel death two harmless Chinamen, paying as a reward for each gory head the sum of five dollars. Then the writer's imagination broke loose, and there followed a far from pretty description of the return of the head-hunters, bringing the proofs of their

success to the officer's house, and receiving praise and dollars. As a matter of fact, a week before the article appeared in print, the "savage head-hunters," neatly dressed in khaki uniforms and saluting smartly, had returned to the officers' bungalow bringing the Chinamen's heads, and receiving praise and dollars. Unfortunately for the truth of the globe-trotter's story, the bodies of the Chinamen were still attached to their heads, and the savage head-hunters held each his prisoner firmly by the pigtail. The Chinamen, having been duly tried and punished, were sent back to the estate to complete their contracts, and in all probability are still planting tobacco, sadder and wiser men.

## A LAND OF GOLD AND MARBLE.

SOME REMARKABLE CAVES.

ABOUT seventeen miles from Goulburn, the metropolis of the southern portion of New South Wales, is the somewhat picturesque township of Bungonia, pleasantly situated on the banks of a wide creek, which, with three others—the Yaequa, Spring Pond, and Terrara—within a short distance of each other, assist in making the district one of an exceptionally fertile character. Many parts of the district are auriferous, and some day will be found richly productive. The Marulan country, in which Bungonia is situated, has long been regarded as one of the future centers of the gold-mining industry in the State. In some places the limestone formations are of considerable extent, and in the masses of limestone rock, at some points yielding marble equal to any imported from Italy, that obtained from the vicinity of Marulan township being unsurpassed in beauty and quality, are several groups of caves, of which only a portion have been explored. Practically, the work of exploration was not systematically commenced until the last few years, owing to the dangerous character of the undertaking, visitors being content with entering the mouth of what may be regarded the principal cave system, and peering into the murky darkness beyond. The entrance-chamber, the roof of which is about 80 feet above the ground, is known as the Belfry, from its conical shape. From here a shaft, some 150 feet in depth, is descended by means of a windlass and rope, the water-worn and polished appearance of the sides of the shaft bearing evidence to the chasm having been periodically, at no distant date, the scene of an immense subterranean waterfall. Proceeding along one of two passages, a couple of large chambers are traversed, after which, passing a distance of some 200 feet, two more chambers, filled with beautiful stalactites, are entered. Beyond here the cave opens out into what may be termed an immense natural tunnel, at least 300 feet in length, and, in places, 100 feet in height and 50 feet in width. The side walls are vertical, and the roof semi-circular, the whole, on account of the smooth and true surfaces everywhere presented, bearing the appearance of having been chiseled out by man. At this point the work of exploration has ceased for the present. The second passage running from the bottom of the shaft, although not very extensive, contains some interesting stalagmitic basin-like growths, which have formed in a series of terraces on the lower portion of the walls and floor, and, as would appear to be very frequently the case, each row of basins is filled with pure water, which, dripping into the next series and so on till it reaches the lower depths, presents a pretty sight. Another cave formation, in the same neighborhood, has also been partially explored. It is entered through an opening in the face of the rock, about 200 feet above the base, the entrance, from 20 feet to 40 feet in height, and averaging 10 feet in width, extending a distance of nearly 1,000 feet. From the same landing a rough, craggy chasm and water extend easterly nearly 1,200 feet, the roof being at a height of from 30 feet to 100 feet. Here are to be seen myriads of stalactites, of all shapes, several being over 10 feet in length. For a distance of 900 feet there are a series of drops of from 4 feet to 5 feet each, until a descent of 60 feet necessitates the use of a rope. Another watercourse joins here. Stalactites are still observable on all sides. The height of this portion varies from 40 feet to 100 feet, and the width to 40 feet. Descending another drop of 20 feet, and traveling in a northerly direction 600 feet, with a continual downward slope, the most spacious and beautiful chamber of the series is seen. The height is not less than 130 feet, with a width of 60 feet. The arched roof of the cave is of smooth blue limestone, with veins of white marble running through in every direction. There are numerous very remarkable bunches of stalactites, and a large fossil, resembling a porcupine, is visible at a distance of 150 feet. A beautiful stream of water passes through the cave, forming on the floor basins of all shapes and sizes. Between 2,000 feet and 3,000 feet further on smaller caves are reached, giving evidence of great bodies of water having passed through. About three miles from the Bungonia caves, and six miles from Marulan, are the Terrara caves. The mouth of the cave or entrance is a well-shaped opening, large enough to admit of two persons entering together. From here the passage descends at a steep incline to the first cave, of comparatively small size, from which a further descent leads to a lofty chamber, "made up of immense jagged rocks wedged together above and below, and containing a few specimens of a discolored drapery-like stalactite formation. From this chamber an ascent of 8 feet is made over a growth of stalagmite, resembling a canopy, when a passage, bearing north about 30 feet in height by 3 feet in width, is entered. The walls of this passage are buttress-shaped, crystallized, and covered with a pretty coral-like formation. Leaving this passage, a

\* Chambers's Journal.

comparatively good track, another section of the most general form of structure of the cave is traversed, necessitating the descent of the fissure being made at an angle, with little or no foothold, and which is accomplished by wedging one's self between the sides, thus bridging the crevice and moving downward by degrees carefully, as a slip in such a place would mean a sudden plunge into the darkness below." In due course another chamber is reached, when further progress is stopped by an immense chasm, some 90 feet in depth, with a pool of water at the bottom. The whole country forms an almost inexhaustible field for those interested in the work of cave exploration.—English Mechanic and World of Science.

#### TRADE NOTES AND FORMULÆ.

**Brown Varnish for Locksmiths' Goods.**—Such a varnish for bright goods to be dried in the stove is prepared as follows: Heat 10 parts of Syrian or Gisonite asphalt, 30 parts of matured linseed oil, 2 parts of red lead, and 2 parts of litharge until the mixture draws threads, let cool, and stir 30 parts of oil turpentine into it.—Neueste Erfindungen und Erfahrungen.

**Simple Coloring of Bronze Powder.**—In order to impart different colors to bronze powders such as pale yellow, dark yellow to copper red, a peculiar knack is employed, consisting in heating the powder with constant stirring in flat iron pans until through the oxidation of the copper—the bronzes consist of the brass powder of an alloy from which the so-called Dutch gold is produced—the desired shade of color is reached. As a rule a very small quantity of fat, wax, or even paraffine is added in this operation. The bronze powders are employed to produce coatings or certain finishes on metals themselves or to give articles of wood, stone, pasteboard, etc., a metallic appearance.—Der Metallarbeiter.

**The Prevention of the Inflammability of Benzine.**—Regarding this subject, Brodtmann says in the Pharmazeutische Zeitung: As I sometimes have to use a mixture of carbon tetrachloride and benzene under conditions where the question of inflammability is of importance, I had occasion to test the statements made in this respect. I prepared mixtures of benzene and carbon tetrachloride in various proportions of volume, and have found that a mixture of 7 volumes tetrachloride and 3 volumes of benzene was still inflammable upon the approach of a match. The liquid burned with a strongly shooting flame under development of hydrochloric acid fumes. Only when the proportion reached that of 9 parts of tetrachloride to 1 of benzene did the liquid require heating to inflame, but the flame soon became extinguished by itself.

**Floors Grained Like Oak.**—A floor showing the veining of oak wood is much prettier than one coated with gray or brown paint. Prepare a paint of two-thirds of white lead and one-third of golden ocher with the requisite amount of boiled linseed oil and a little drier, and cover the floor twice with this mixture, which possesses great covering power. When the last coating is dry, paint the floor with a thin liquid paint consisting of varnish and terra di Siena, applying the same in the longitudinal direction of the boards. Treat a strip about 50 centimeters wide at a time, and draw at once a broad paint brush or, in the absence of such, an ordinary brush or goose feather along the planks through the wet paint, whereupon the floor will acquire a nicely grained appearance. The paint requires several days to dry. A subsequent coating of varnish will cause the graining to stand out still more prominently.—Zentralblatt, Stuttgart.

**Testing of Wax.**—Wax is adulterated with the following among other substances: rosin, pitch, flowers of sulphur, starch, fecula, stearine, paraffine, tallow, palm oil, calcined bones, yellow ocher, water, and wood sawdust.

Resins are detected by cold alcohol, which dissolves all resinous substances and exercises no action on the wax. The resins having been extracted from the alcoholic solution by the evaporation of the alcohol, the various kinds may be distinguished by the odors disengaged by burning the mass several times on a plate of heated iron.

All earthy substances may be readily separated from wax by means of oil of turpentine, which dissolves the wax, while the earthy matters form a residue.

Oil of turpentine also completely separates wax from starchy substances, which, like earthy matters, do not dissolve, but form a residue. A more simple method consists in heating wax with boiling water; the gelatinous consistency assumed by the water, and the blue coloration in presence of iodine, indicate that the wax contains starchy substances. Adulteration by means of starch and fecula is quite frequent. These substances are sometimes added to the wax in a proportion of nearly 60 per cent. To separate it, the suspected product is treated hot with very dilute sulphuric acid (2 parts of acid per 100 parts of water). All amylaceous substances, converted into dextrine, remain dissolved in the liquid, while the wax, in cooling, forms a crust on the surface. It is taken off and weighed; the difference between its weight and that of the product analyzed will give the quantity of the amylaceous substances.

Flowers of sulphur are recognized readily from the odor of sulphurous acid during combustion on red-hot iron.

Tallow may be detected by the taste and odor. Pure wax has an aromatic, agreeable taste, while that mixed with tallow is repulsive both in taste and smell. Pure wax, worked between the fingers, grows soft, preserving a certain cohesion in all parts. It divides into

lumps, which adhere to the fingers, if it is mixed with tallow. The adulteration may also be detected by the thick and nauseating fumes produced when burned on heated iron.

Stearic acid may be recognized by means of boiling alcohol, which dissolves it in nearly all proportions and causes it to deposit crystals on cooling, while it is without action on the wax. Blue litmus paper, immersed in alcohol solution, reddens on drying in air, and thus serves for detecting the presence of stearic acid.

Ocher is found by treating the wax with boiling water. A lemon-yellow deposit results, which, taken up with chlorhydric acid, yields with ammonia a lemon-yellow precipitate of ferric oxide.

The powder of burnt bones separates and forms a residue, when the wax is heated with oil of turpentine. From the acid liquid phosphate of lime is precipitated by means of ammonia and oxalate of lime by the oxalate of ammonia.

Wood sawdust is recognized by means of oil of turpentine.

Wax contains water when it diminishes in weight as the consequence of desiccation.

The presence of paraffine may be observed in the following manner: A small piece of the suspected wax is introduced in a porcelain dish, and heated with fuming sulphuric acid. When the substance is fused, an effervescence is produced, the more active in proportion to the quantity of wax. When the effervescence ceases, it is heated a little and allowed to cool. The paraffine collects on the surface of the liquid, and it is pure if sufficient acid has been employed; if not, it may be mingled with the products of decomposition of the wax; it will then be sufficient to remelt it in another boiling acid.—Translated from Les Corps Gras Industriels.

#### ELECTRICAL NOTES.

**Electrolysis** as a means of destroying certain classes of navi and for removing hairs and small moles may be given a place in the list of first-class matter contributed to medical practice by electricity. Although the conditions relieved are not dangerous to life, yet the method gives results which are not attainable by any of the older procedures. There are large numbers of people who either are, or ought to be, very grateful for the results which electrolytic methods have given to them in the direction of cosmetic surgery.

A signaling apparatus intended to avoid any accidents in single-track service has recently been installed by Messrs. Siemens & Halske on their Behrenstrasse-Treptow tramway line. The apparatus, which is arousing much interest owing to its novelty, has been erected at the angle of Hollmannstrasse and Lindenstrasse, and is of quite similar shape and construction to the type of safety apparatus used in connection with standard railways. A huge pole installed at the angle carries for each direction an arm which, on being drawn up, advises the driver from a distance that the track is free, while otherwise hanging down. The only difference from the practice of standard railways is the fact that with the latter the levers work automatically, whereas an employee is in the present case permanently required to control the apparatus. At night the signal levers are lighted by strong reflecting lamps. This interesting novelty has been installed as a consequence of the paving work which required a provisional single-track service for a section of the track alongside Hollmannstrasse.

**Sig. Niccolò Pizzarello**, lieutenant of the Italian engineering corps, recently submitted to the Turin Academy of Sciences the results of an interesting experiment, an account of which is given in a recent issue of L'Elettrotecnica. The author used for the wireless transmission of signals in the transmitting station an electrostatic Wimshurst machine, having disks of 40 centimeters in diameter, and in the receiving station a coherer with its relay. According to some experimenters, the medium through which the signals are transmitted is the air, and according to others the earth. As, however, all experiments agree in showing that the earth exercises a strong influence on the transmission of signals, the latter supposition would seem to be true, the more so as even in the most powerful stations a transmission is obtained only over short distances without the aid of an excellent earthing. The arrangement designed by the author for the transmission of signals was as follows: One of the electrodes of the Wimshurst machine was or was not provided with a point, the other being placed in the neighborhood of a sphere immediately communicating with the ground, and to which the sparks were made to pass. Now, when producing sparks of extreme shortness (sometimes less than one millimeter in length) the receiving apparatus would respond regularly to any one of the sparks. If, on the other hand, the sparks were even some centimeters in length between two electrodes, of which one was in connection with the earth and the other with a point, the receiving apparatus did not give the least response. The coherer of the receiving apparatus was on the one hand connected with the earth, and on the other to a point or to any kind of conductor of even imperfect insulation. Whereas, however, the point at the sending station did not augment or decrease the observed effects, this as a conductor was found to be indispensable in the receiving station to insure a regular working. This regularity was observed even when using the electrostatic machine without any Leyden jars. The author has not yet been able to drive his experiments beyond the distance of 50 centimeters, nor was he in a position to carry

out any experiments between rooms situated in different buildings. He, however, intends eventually investigating all these points, and in the meantime draws attention to the fact that even coarse-grained coherers of small sensibility readily respond to the sparking of an electrostatic machine.

#### ENGINEERING NOTES.

Considering the substances which cause incrustation, the most reliable remedy is the precipitation of the salts by chemical action before the water is supplied to the tenders. For the balance of the incrusting and priming substances, the best remedy is frequent blowing out, a thorough washing out with hot water under heavy pressure at periodical intervals, and the addition of a small amount of vegetable oil to reduce the surface tension and prevent foaming of the liquid.

The ordinary coal-oil lamp is one of the best illustrations of perfect combustion and consequent smoke prevention. The heated gases rising in the chimney produce a draft and fresh air is continually drawn in at the bottom through the hot gauze which warms and divides it so as to insure thoroughly mixing with the gases from the burning oil. Turn up the wick and the flame becomes smoky—too much hydrocarbon for the air supply. Raise the chimney slightly from the bottom and again there is smoke—too much air at too low a temperature which chills the flame. Insert a cool metal rod into the chimney and soot is deposited on it—chilling of the flame again and disengagement of the carbon, while the hydrogen continues to burn. And thus we may learn of the three requisites for good combustion; enough air, a sustained high temperature, and a thorough mixing of the gases. The last two are so important that it is entirely possible to have an excessive supply of air and dense black smoke at the same time.

The combustion of hydrocarbons seems to be always incomplete at first. If one watches the slow burning of a lump of candle in the open grate he will see a whitish or yellowish vapor expelled from the coal by the gradual heat of the fire. This is the carbon and hydrogen combined which is distilled by the heat and leaves behind the free carbon as coke. While the escape of this vapor unburned represents a distinct loss of heat, the vapor is not smoke as we understand it. It does not deposit soot and will not stain or disfigure surfaces in its path. As the heat increases, and air is supplied, the vapor ignites and burns with a yellow flame showing the presence of solid particles. If the temperature remains high and the air supply continues, the combustion is complete and the colorless carbon dioxide and water vapor pass up the chimney. If, however, the burning gas becomes chilled by contact with the relatively cool bricks of the chimney back or if insufficient air is supplied, the yellow flame becomes red and dingy, while particles of finely divided carbon are deposited on the adjacent surfaces or whirled away up the chimney.

It is no small task properly to direct the design, to operate and maintain a thousand or more traveling power stations, such as modern locomotives have become, and to build up a policy and an organization sufficient for such an undertaking on a single road, let alone doing this for a combination of roads. No other class of men in the world—without exception—is ever called upon to do what is everywhere expected of motive power officers, and the demands increase continually. The problem has grown perceptibly in two years and enormously in five. The problem is the selection, preparation, and training of men. If this is provided for the rest is easy. It is said to be less difficult to secure a new president than to secure a good shop or roundhouse foreman. This is, of course, not true, but it certainly is sufficiently difficult to obtain the necessary supply of foremen of the right sort and even more difficult to secure the right kind of men in the ranks. The men are not essentially different from those of a generation ago, but the conditions certainly are different. To improve conditions it is necessary to know what is wrong, and to know what is wrong it is necessary to understand the changes which the last few years have brought.

The theoretical principles of engineering are as broad as the universe; the practical principles may be followed all around the world subject to the laws of climate and of commerce; but human engineering is racial, provincial, or individual. A volume of surprises! Open it and read. There is more thread to the story than has a dictionary. The world stands shoulder to shoulder like substantives with ne'er a connective nor qualifier, and it is this last phase of engineering which is latest acquired in the education of engineers for the rank of division engineers. This human engineering separates the assistant engineer from the division engineer. It is the quality which bridges over the chasm between the assistant engineer and the road-master. As a qualification in engineering ability, it commands a higher salary than did the added qualification, which in turn made us draftsmen, instrument men, or assistant engineers. Too much stress can not be placed on the value of the study of men when a man is an assistant engineer. When one can do any of the field and any of the office work on the division, it is most natural to think he can handle the work as a division engineer, but he would probably be unreasonable with foremen and be an expensive man for the company. He knows the theoretical and the practical engineering, but he does not understand human nature, and, therefore, will not succeed in handling men.

## SCIENCE NOTES.

A class of carbides, such as those of silicon, boron, chromium, molybdenum, tungsten, and titanium, are stable, not only resisting the attack of water but being extremely resistant to the most active chemical agents. The first of these, silicon carbide, or carborundum, has found extensive application as an abrasive, and its use has led to the development of a new industry. Its extreme hardness, approaching that of the diamond, and the refractory nature of it and similar carbides, together with properties which may yet be discovered, point to the probability as well as the possibility that other carbides will have quite as extensive industrial application.

We must distinguish between the science of geography, which consists in ascertaining and co-ordinating new facts and putting them into a shape for the use of others, which is the work of comparatively few; and the practical geography which consists of making use of that work, and, as in many other branches of science, is within the reach of all who choose to devote time to it. It is impossible to have a clear comprehension of history, whether past or current, without calling in the aid of geography; but unfortunately much history has been written and taught without such aid. To read the daily papers requires either geographical knowledge or constant reference to maps, and if readers would only make a practice of such reference on every occasion when they are at fault, they would soon find themselves acquiring knowledge of the greatest use to them in the easiest and most interesting manner and with the smallest expenditure of time. The mistakes made even by those responsible for the conduct of public affairs, by reason of the want of this essential but elementary knowledge, are innumerable, and to this day there are many who consider themselves highly educated and capable men who cannot even rightly understand a map.

The whole of geology was a gift of the nineteenth century. There was nothing that deserved the name before it, yet more than half of the land of the globe has not yet been surveyed, and many geologic problems are yet unsettled, concerning regions that have been studied. The mineralogical relations and precedents among basalts, granites, and other rocks, as well as the physical conditions that determined composition, arrangement, and distribution, remain to be determined. Volcanic phenomena are not at all well understood. The composition of the interior of the earth is quite unknown, its temperature, and the rate of heat conductivity of the various rocks—questions which, when answered, will have much to say about the age of the earth and especially of the length of time since it has been a habitable body for any living things. At present there are two camps interested in this question, with lower time limits from ten million to a thousand million years. When Asia, Africa, and South America have been as well studied as Europe and North America have been, there will probably be found vast stores of metals, coal, oil, and valuable minerals, thus adding to the world's stock of needful things. Also the discovery of new varieties of fossils, the ancestors of living species, especially of mankind, missing links, will add to the interest in human affairs. Geologists have for years been trying to find some definite measure for geologic epochs, to ascertain how long ago the glacial age was, and how long it lasted. At present there are only surmises that the glacial epoch ended from 10,000 to 50,000 years ago. The twentieth century will probably be able to settle this.

Many of the so-called olive oils offered for import are mixed with large or small quantities of other edible oils. There are a great many vegetable oils which are excellent for edible purposes; for instance, as is well known, the purified cotton-seed oil, which is produced in large quantities in this country, is an excellent edible oil. In like manner, peanut oil possesses properties which commend it very highly as an edible product. Sesame oil, which is not produced to any great extent in the United States but is a large commercial product in southern Europe, is also an edible oil of fine quality. Perhaps the best of all of the vegetable oils other than olive is that of the sunflower seed, which, however, is not manufactured commercially in the United States, and which, in so far as is known to the Bureau of Chemistry, is not used to any large extent as an adulterant of olive oil. It is claimed by some manufacturers that the introduction in small quantities of these edible oils improves the character of olive oils. This may or may not be so, but at any rate the fact has no bearing on our own law relating to imports. It is evident that an olive oil which contains any added portion of another oil and yet bears on its label the term "pure olive oil" or "olive oil" is misbranded, since the contents of the package are not pure olive oil or olive oil. Fortunately, chemical processes have been so refined as to enable the inspector to determine even the addition of small quantities of such edible oils to an olive oil. A great many of such invoices have been inspected and found, by reason of the false label, unfitted for importation. In order to avoid unnecessary inconvenience, in the first instance of this kind, where it was apparent that the importer was perfectly innocent of any intention to defraud, he has been allowed to relabel the packages in such a way as to plainly show that they contained a compound. This, however, was only a temporary expedient for the convenience of the importer. It will be necessary in future, in order to strictly comply with the provisions of the law, that the original label be so printed as to indicate the character of the mixture.

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